ANATOMIA BRITANNICA.

A

SYSTEM

OF

ANATOMY AND PHYSIOLOGY,

SELECTED FROM THE WORKS OF

HALLER, ALBINUS, MONRO, WINSLOW, HUNTER, SOEMMERRING, SCARPA, CRUIKSHANK, MASGAGNI, MURRAY, WALTER, SABATIER, MECKEL, ZINN, &c. &c. &c.

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A

SYSTEM

OF

ANATOMY and PHYSIOLOGY.

PART SECOND.

SECTION I.

SPLANCHNOLOGY.

WE now proceed to consider that part of the human body, with the organs subservient to it, from which principally absorption takes place, and on which therefore nutrition and the whole process of vitality depends. This is the intestinal canal, with the other viscera of the abdomen. But it will first be necessary to consider the mouth, pharynx, and œsophagus as organs of mastication and of deglutition.

OF THE MOUTH, SALIVAL GLANDS, PHARYNX, AND ŒSOPHAGUS.

Much of the food of animals requires mastication, to divide it into less cohering parts, that it may more easily yield to the dissolving powers of the gastric juice.

Therefore most animals are provided with teeth extremely hard; and as the materials of food are various in their texture and firmness, nature has accordingly made the teeth of various figures.

The office of the incisores is only, in the softer foods, to cut those which are tougher than the rest into smaller portions; such as the fibres and membranes of animals and vegetables, with the brittle seeds and kernels of fruits.

The canine teeth lacerate tough aliments, and hold fast such as require long trituration by the grinders.

Betwixt the molares the most compact foods are interposed and broke, as the more tough and hard are ground smaller, while the lower teeth are urged obliquely and laterally against the immoveable upper ones; and these are the teeth which principally perform mastication.

But that the teeth might break or grind the food with due strength and firmness, the uppermost are fixed into the sockets of the immoveable upper jaw, as the lower ones are into the lower moveable jaw, which is so joined with the temporals, that it may be drawn down from the upper jaw, and pulled up against it with force; and may be moved laterally to the right or left, and forward or backward. Those various motions of the lower jaw depend upon the articulation of its condyles, in which the lateral parts of the jaw terminate. This joint, as was already mentioned, has the freer liberty in moving, by the interposition of a small cartilaginous plate, betwixt the condyle of the jaw and tubercle of the temporal bone.

The muscles moving the lower jaw, which are comparatively weak in man, but very strong in brute animals, are the temporalis and masseter which act in concert; but the temporal muscle brings the jaw more backward, and the masseter forward. The *pterygoideus internus* elevates or draws it to one side or to the other alternately. The *pterygoideus externus* proceeds backward and downward into the anterior part of the condyle of the lower jaw, which it moves laterally, and draws forward before the upper jaw.

The lower jaw is depressed, so as to open the mouth by the digastric muscle. But the mouth may be partly opened by all the other muscles of the lower jaw, os hyoides, and larynx, as the genio-hyoideus, genio-glossus, sterno-hyoideus, sterno-thyroideus, coraco-hyoideus, and latissimus colli. The genio-

hyoideus and digastric muscles have also a power of drawing the jaw backward.

The lower jaw is elevated with a great force, so as to divide the food by the pressure of the upper and lower teeth against each other, by the action of the temporal, masseter, and internal pterygoid muscles; the contraction of which appears by experiment to be very powerful, and sufficient to raise several hundred weight. The lateral and circular motions of the jaw upon one of its moveable condyles are performed by the external and internal pterygoidei, acting either alone or together with the former. Thus the food is cut, lacerated, and ground to pieces; and if the mastication be continued diligently, it is, together with the liquors of the mouth, reduced into a kind of pulp.

During the trituration of the food in the mouth, there is continually poured into it a large quantity of a watery clear liquor, evaporable or insipid, or at least but very little saline, and containing but little earth; of this liquor there are numerous springs in the neighbourhood. A large quantity of this *saliva* is separated by numberless small glands of the lips and cheeks; and the juice poured out from the exhaling vessels of the tongue, mouth, and cheeks, is of the like kind, or rather more watery.—The quantity produced is very considerable, as twelve ounces have been known to flow out from wounds in those parts in the space of an hour. By good-mannered people it is for the most part swallowed; and usefully, as it cannot be thrown away without hurting digestion.

The salival glands especially, supply the watery humour called after their own name, and they may be enumerated in the following manner: glandulæ parotides, glandulæ maxillares, glandulæ sublinguales, molares, buccales, labiales, linguales, amygdalæ, palatinæ, uvulares, arytenoideæ, glandula thyroidea.

The PAROTIDES are two large, whitish glands, irregularly oblong and protuberant, situated on each side, between the external ear and the ramus of the lower jaw, and lying on some part of the neighbouring masseter muscle. The superior portion of this gland lies before the cartilaginous meatus of the ear, and touches the apophysis zygomatica of the os temporis; and it is extended

forward and backward under the lobe of the ear, as far as the mastoid apophysis.

From the anterior and superior portion of this gland, a white membranous duct or canal is produced by the union of a great number of small tubes representing so many roots. This duct runs obliquely forward on the outside of the masseter; and then perforates the buccinator from without inward, opposite to the interstice between the second and third dentes molares, where the hole or orifice represents the spout of an ewer.

This canal is about the twelfth part of an inch in diameter, and on the outer side of the masseter muscle it receives sometimes one and sometimes two small ducts from a like number of little glands; which Haller calls *glandulæ accessoriæ*. The external carotid artery and vein, and the portio dura of the seventh pair of nerves, pass through the substance of the parotid gland, to which they give branches; and the facial artery and vein pass over its duct.

The MAXILLARES are smaller and rounder than the parotides; and are situated each on the inside of the angle of the lower jaw, near the musculus pterygoidæus internus. From the inside, or that which is turned to the musculus hyo-glossus, each of them sends out a duct in the same manner as the parotides; but it is smaller and longer.

This duct advances on the side of the musculus genio-glossus, along the inner part and superior edge of the glandula sublingualis, to the frænum of the tongue, where it terminates by a small orifice in form of a papilla.

The SUBLINGUALES are likewise two in number, of the same kind with the former, only smaller, something oblong, and flatted. They are situated under the anterior portion of the tongue, one on each side, near the lower jaw, on the lateral portions of the musculi mylo-hyoidei which sustain them. The two extremities of each gland are turned backward and forward, and the edges obliquely inward and outward.

They are covered on the upperside by a very thin membrane, which is a continuation of that that covers the underside of the tongue. They send out laterally several small short ducts which open near the gums by the same number of orifices, all ranked

in the same line, at a small distance from the frænum, and a little more backward. In many animals we find particular ducts belonging to these glands, like those of the glandulæ maxillares, but they are not to be found so distinctly in men. The musculi genio glossi lie between the two sublingual glands, and also between the two maxillary ducts. The arteries and veins of these and of the former glands belong to the lingual vessels, and the nerves are from the lingual branch of the fifth pair.

The *molares* are two glands nearly of the same kind with the former, each of them being situated between the masseter and buccinator; and in some subjects they may easily be mistaken for two small lumps of fat. They send out small ducts which perforate the buccinator, and open into the cavity of the mouth, almost over against the last dentes molares; and thence they derived their name.

All the inside of the cheeks, near the mouth, is full of small glands, called *buccales*, which open by small holes or orifices through the inner membrane of the mouth. The membrane which covers the inside of the lips, a continuation of that on the cheeks, is likewise perforated by a great number of small holes, which answer to the same number of small glands, called *labiales*. The *linguales* belong to the tongue, the *palatinæ* to the arch and septum of the palate; and the *arytenoideæ* are connected to the larynx. The *uvular glands* are only a continuation of the membrane of the palate in form of a small bunch of grapes. We might likewise reckon among the salival glands those of the superior portion of the pharynx, and also the follicles of the membrana pituitaria of the nares, and of the sinuses which communicate with these.

The *amygdalæ* are two glandular bodies of a reddish colour, lying in the interstices between the two lateral half arches of the septum palati, one on the right, the other on the left side of the basis of the tongue. Their appearance is not unlike that of the outside of an almond-shell, both because their surface is uneven, and because it is full of holes big enough to admit the head of a large pin.

These holes, which represent a sieve, or a piece of net-work,

are continued to an irregular sinus or cavity within the gland, filled commonly with a viscid fluid, which comes from the bottom of the sinus, and is thence gradually discharged through these holes into the throat.

The THYROID GLAND is a large reddish mass which covers the anterior convex side of the larynx. It seems at first sight to be made up of two oblong glandular portions united by their inferior extremities, below the cricoid cartilage, so as to resemble a crescent, with the cornea turned upward. Its lateral portions lie on the thyrohyoidei, and its middle portion on the cricothyroidei.

This gland resembles the other saliva glands, but is more solid. No excretory duct has been discovered to it.

By the motion of the jaw in mastication, the salival glands are compressed, so as to discharge their juices into the mouth in great plenty. When the mouth is opened, the maxillary gland being pressed by the digastric and mylo-hyoideus, throws forth abundance of saliva; the masseter when swelled presses the parotid gland, as does also the cutaneous muscle of the neck which lies over it: and it is this muscular pressure that excites the appetite, and pours the saliva into the mouth.

The food, therefore, being in this manner ground betwixt the teeth, and intermixed with the watery saliva and air, is broken down into a soft juicy pulp, pliable into any figure, and replete with elastic air, which, by the action of the latter, undergoes a further dissolution.

But the motions which are necessary for turning round the food, applying it to the teeth, and conveying it through the different parts of the mouth in mastication, are performed by the tongue, cheeks, and lips.

The various motions of the tongue are likewise governed by the muscles and membranes, largely inserted into the os hyoides; and this bone being drawn down by its respective muscles, depresses the tongue at the same time, and the lower jaw likewise, if the muscles of that be relaxed. These powers are the sterno-hyoideus, sterno-thyroideus, hyo-thyroideus, thyreopharyngeus, and coraco-hyoideus.

The muscles which elevate the os hyoides, together with the

tongue, are its styloglossus muscle, sustained by a peculiar ligament of the upper jaw, the *stylohyoideus*, and second *stylohyoideus*. All these muscles draw the tongue back, but laterally they elevate it. The *mylohyoideus* elevates the tongue, and fixes it in making various motions, or in like manner depresses the jaw. The *geniohyoideus*, being a companion of the genioglossus, pulls the tongue forward out of the mouth.

But the muscles of the cheeks variously move and press the food in the mouth. Some move it from the cavity of the cheeks into the inner cavity of the mouth behind the teeth, as we see in the buccinator when the mouth is shut. Others open the mouth for receiving the food; such as the proper elevator of the upper lip, and the elevator anguli oris; to which add, the zygomaticus, major and minor; the buccinator, depressor anguli oris, and depressor labii inferioris. Others, again, close the lips, that the food received may not return out of the mouth; such as the orbicularis of each lip, the proper depressor of the upper lip, the proper elevator of the lower lip, and that which serves in common for the elevation of both.

By these means the food, ground and mixed with the saliva into a soft pulp, collected from all parts of the mouth by the tongue into the arched space betwixt the teeth, is afterward, by the expansion and successive pressure of the tongue, conveyed backward behind the teeth; and, in this action, the tongue is expanded by the hyoglossi and genioglossi, and rendered a little concave by the styloglossus. Thence it is next conveyed into the fauces.

For the tongue being raised by the styloglossi, and broadly applied to the palate, first by its apex, then also insensibly by its posterior extremity, presses the food successively toward the fauces, which at that time alone afford an open passage. After this, the thick root and back part of the tongue itself, by the forementioned muscles, and by the stylohyoidei and biventers carried backward, presses down the epiglottis. At the same time, the muscles elevating the pharynx all act together; such as the biventer, geniohyoideus, genioglossus, stylohyoideus, styloglossus, stylopharyngeus, and the other elevators, which now

draw the larynx upward and forward, that the epiglottis, being brought nearer to the convex root of the tongue, may be better closed or depressed. Hence it is necessary toward deglutition for the jaws to be closed, that by this means the biventer may have a firm support; and, together with the muscles already described, elevate the os hyoides. Thus the epiglottis, being inverted, shuts up and covers the passage very exactly, into the larynx, over which it is extended like a bridge for the aliment to pass over into the fauces.

The pharynx, the general structure of which was formerly described, is dilated in its action by the powers serving to its elevation; such as the *stylopharyngeus*, the *thyreopalatinus*, &c. and it closely surrounds and follows the food, on each side the epiglottis, above the larynx, that it may thence fall into the œsophagus.

That the aliments might not regurgitate into the nostrils at the time when they are pressed into the dilated pharynx, a moveable velum or palate is interposed. The elevator of this velum, with its companion, forms an arch, which is moveable with the palate itself, between the two plates of the thyreopalatinus, so as to be brought into a close contact with the sides of the nares, and with the Eustachian tubes, that none of the aliment may enter into either of them. But this elevator does not seem to have any considerable action in swallowing. At this time, regurgitation into the nostrils is prevented by a constriction of the muscles of the pharynx, together with a depressure of the thyreopalatinus, which then manifestly draws the moveable velum downward and toward the tongue and pharynx. Add to these, the *circumflexus palati mollis*, which is able both to open the tube, and to press down the moveable velum of the palate. Thus the pharynx being contracted like a sphincter, drives down the food, without permitting any part to return back into the cavity of the nares.

During this endeavour to depress the food by the pharynx, the velum, drawn back and expanded, is pulled down toward the tongue, by the action of the palatopharyngei, and by the circumflex muscles of the soft palate. These muscles, together with the glossopalatinus, press the velum against the protube-

rant root of the tongue, and intercept any return to the mouth and nostrils. After there is no further danger of any part falling into the windpipe, the epiglottis is raised up again, as well by its own elasticity, as by the elevation of the tongue itself, by which it is drawn forward. Lastly, the depressed uvula is raised by the azygos, which arises from the tendons of the circumflexi muscles and levator of the soft palate.

A little after this follows an attempt to urge the food downward, which is exerted by the constrictor muscles of the pharynx which draw the foreparts toward the back, and by the muscles which are partly transverse and partly ascend into the posterior surface of the pharynx. These muscles acting successively from above downward, according to their situation, drive the aliment into the œsophagus. At the same time the depressing muscles of the larynx, coracohyoideus, sternohyoideus, and sternothyroideus, draw down the larynx forward, and lessening the capacity of the pharynx urge the food downward. But in this action, as the aliment passes by the posterior rima of the glottis, the arytænoidei contract the larynx perpendicularly.

As various dry and rough bodies are frequently swallowed, it was necessary for the pharynx to be dilatable and not very sensible of pain; to which end the great quantity of mucus, which is collected in all parts of the fauces, greatly conduces. Therefore, in general, betwixt the nervous and innermost coat of the pharynx, are placed a great number of simple mucous follicles or cells, pouring out their contents through short mouths; of a soft, viscid, and somewhat watery nature; but ropy, or drawing out into threads, not without oil, and abounding more with volatile salt and earth than the saliva itself.

The aliments are moved through the œsophagus as through an intestine. The longitudinal fibres, ascending to the cartilages of the larynx, dilate the gullet, opposite to the descending morsel. But when it is received, the longitudinal fibres equally dilate and elevate the gullet at that place which receives it. Then that part of the œsophagus where the morsel is seated, being irritated, contracts, and moves the food downward.

The œsophagus being a canal partly muscular and partly

membranous, commences at the inferior part of the pharynx, and descends along the neck and back part of the thorax into the abdomen. While it lies in the neck, it is placed between the middle and left part of the cervical vertebræ behind the left part of the trachea; in the thorax, it is situated between the layers of the posterior mediastinum, and descends to the fourth or fifth vertebra of the back, in the same direction which it had above: there it inclines a little from left to right, till it reaches the ninth rib, to make way for the aorta; afterward it inclines from right to left, and from behind forward, to get through the diaphragm into the upper orifice of the stomach.

It is made up of several coats almost in the same manner as the stomach, which is its continuation. The first coat, while in the thorax, is formed only by the duplicature of the posterior part of the mediastinum, and is wanting above the thorax and in the neck, where the outer coat of the œsophagus is only a continuation of the cellular membrane belonging to the neighbouring parts.

The second coat is *muscular*, being made up of several strata of fleshy fibres. The outermost are mostly longitudinal, and their quantity is much greater than that on the rest of the alimentary canal; but they are not all continued from one end of the œsophagus to the other. The following strata are obliquely transverse, and the innermost are turned a little obliquely the contrary way. They cross each other irregularly in many places, but are neither spiral nor annular.

The third is termed the *nervous* coat, and is like that of the stomach and intestines. It is differently folded or plaited, according to its length, being much wider than the muscular coat; and it is surrounded by a whitish, soft, fine filamentary substance, like a kind of cotton, which, when steeped in water, swells and grows thicker.

The fourth or innermost coat resembles in some measure that of the intestines; except that, instead of the villi, it has small and very short papillæ. It is folded lengthwise like the third coat; so that the œsophagus, when cut across, represents one tube within another. Through the pores of this coat, a viscid lymph is continually discharged.

By this canal, the food is conducted to the stomach situated in that cavity of the body called the abdomen, to the description of which we now proceed.

OF THE ABDOMEN.

The whole forepart of the abdomen forms an oblong convexity; its greater or less prominence being accidental.

On the sides the abdomen is commonly a little contracted; and backward, it is gently depressed, forming a kind of transverse cavity, answering to the natural incurvation of the lumbar portion of the spine.

This anterior convexity, and posterior cavity, change as we sit, stand, kneel, lie at our full length, or with the thighs bent; and these variations depend on the particular situation of the ossa innominata in these different postures.

In standing, the convexity of the belly, and cavity of the loins, are more considerable than in most other situations; for then the lower extremity of the os sacrum is turned very far back, and consequently the os pubis very much down. In this situation of the pelvis the intestines fall naturally forward, and thus increase the convexity of the abdomen; and as the vertebræ of the loins are very much bent at the same time, the cavity in that place must likewise be very considerable.

In kneeling, the ossa pubis are still lower than when we stand; and this not only increases the hollow of the loins, and throws the abdomen and its viscera more outward or forward, but also in some measure strains the abdominal muscles.

This depression of the os pubis in kneeling depends partly on the tension of the two musculi recti femoris; the lower tendons of which are, in this situation, drawn with violence under the condyloid pulley of the os femoris.

When we sit in the common manner, that is, with the thighs stretched out in a plane parallel to that of the seat, the convexity of the belly and hollow of the loins diminish.

For the pelvis being in this situation supported on the tubercula ischii, and these tubercles being very near the forepart of

the pelvis, the trunk of the body pressing on the os sacrum must lower the pelvis behind, and raise it before.

When we lie upon the back at full length, and with the thighs extended, the belly is less convex, but more stretched and hard; whereas, when the thighs are bent, it is soft and lax. In this situation, the lumbar region is almost flat and very little depressed.

When we lie on the back, and raise the head, or endeavour to raise it, we feel a tension in the forepart of the abdomen, which increases in proportion to the force we use in raising the head.

Integuments of the abdomen. The anterior portion of it is not only thinner and more compact than the posterior, as has been already observed, but it has this likewise peculiar to it, that it may be naturally increased very much in breadth, and sometimes in a very extraordinary manner, without losing any thing of its thickness, in proportion to what it gains in breadth.

The cells of the membrana adiposa, which covers the convex part of the abdomen, are disposed in a very regular manner, as we discover by dissecting the skin from the muscles; for then there appears on the inner surface of the membrana adiposa a longitudinal line like a kind of raphe, produced by the meeting of the cellular rows, which form angles successively, one above another, opposite to the linea alba of the abdomen. The cells in these rows are more oblong than the rest, and in a manner oval, or like a grain of wheat.

Cavity of the abdomen. The appendix ensiformis of the sternum, the cartilaginous portions of the last pair of true ribs, those of the first four pairs of false ribs, all the fifth pair, the five lumbar vertebræ, the ossa innominata, the os sacrum, and os coccygis, form the bony sides of the cavity of the abdomen.

The diaphragm, the muscles called particularly musculi abdominis, the quadrati lumborum, psoai, iliaci, the muscles of the coccyx, and of the intestinum rectum, form the chief part of the circumference of this cavity; and its whole inner surface is lined by a membranous expansion, termed *peritoneum*, all these parts being covered by the integuments already spoken of. As additional or auxiliary parts, we might likewise add some

portions of the sacro-lumbares, longissimi dorsi, vertebrales, glutæi, &c.

The cavity of the abdomen is of an irregularly oval figure, but still symmetrical. On the foreside it is uniformly arched or oval, and its greatest capacity is even with the navel, and nearest part of the hypogastrium. On the upper side it is bounded by a portion of a vault, very much inclined. On the back-side it is in a manner divided into two cavities by the jetting out of the vertebræ of the loins. On the lower side it contracts gradually all the way to the lesser edge of the pelvis; and from thence expands again a little as far as the os coccygis, and tubercles of the ischium, terminating in the void space between these three parts.

PERITONÆUM.

Having carefully removed the muscles of the abdomen, the first thing we discover is a very considerable membranous covering, which adheres immediately to the inner surface of the musculi transversi, and of all the other parts of this cavity; and involves and invests all the viscera contained therein, as in a kind of bag. This membrane is named *peritonæum*, from a Greek word, which signifies to be spread around.

The peritonæum, in general, is a membrane of a pretty close texture, and yet very thin and capable of great extension; after which it can recover itself, and be contracted to its ordinary size, as we see in pregnancy, corpulency, and repletion.

It may be looked upon as a single membrane, although it has been described by many anatomists as a duplicature of two distinct membranous laminæ. But, properly speaking, the internal portion alone deserves the name of a *membranous lamina*, as being the main body of the peritonæum. The external portion may properly enough be termed the *cellular substance of the peritonæum.*

The inner surface of the peritonæum is very smooth, and polished on that side which is turned to the cavity and viscera of the abdomen, and continually moistened by a serous fluid discharged through almost imperceptible pores.

These pores may be seen by spreading a portion of the peritonæum on the end of the finger, and then pulling it very tight on all sides; for then the pores are dilated, and small drops may be observed to run from them, even without a microscope. The sources of this fluid are chiefly from the exhalent vessels.

The cellular substance, or external portion of the peritonæum, adheres very closely to the parts which form the insides of the cavity of the abdomen; but it is not every where of an equal thickness. In some places it is in a very small quantity, and scarcely any appears at the tendinous or aponeurotic portions of the musculi transversi, and on the lower side of the diaphragm.

In all other places it is thicker, and forms cells expanded into very fine laminæ, which, in diseased subjects, become sometimes so broad and thick, as to resemble so many distinct membranes.

In some places, this substance is every way like a membrana adiposa, being filled with fat, as round the kidneys, and along the fleshy portions of the tranverse muscles, to which it adheres. It entirely surrounds some parts, as the bladder, ureters, kidneys, spermatic vessels, &c. and it is in these places improperly termed the *duplicature of the peritonæum.*

Besides these differences in thickness, the cellular substance has several elongations, which have been called *productions of the peritonæum.* Two of these productions accompany and invest the spermatic cords in males, and the vascular cords, commonly called the round ligaments, in women. There are other two, which pass under the ligamentum Fallopii, with the crural vessels, which they involve; they are gradually lost in their course downward.

To these four productions of the cellular substance of the peritonæum we may add a fifth, which is spread on the neck of the bladder; and perhaps a sixth, which accompanies the intestinum rectum. All these elongations pass out of the cavity of the abdomen, and may be termed *external,* to distinguish them from others that remain in the abdomen, and are called *internal*; of which hereafter.

The great blood-vessels, that is, the aorta and vena cava, are

likewise involved in this cellular substance of the peritonæum. In a word, it involves immediately and separately all the parts and organs which are commonly said to lie in the duplicature of the peritonæum.

The true lamina, or membranous portion of the peritonæum, is connected by the intervention of the cellular substance to the inner surface of the cavity of the abdomen; but it does not naturally accompany the external elongations of that substance. It only covers the origin or basis of these productions, without any alteration in its own surface at these places.

It has, nevertheless, productions of its own; but they are very different from those of the cellular substance; for they run from without inward, that is, they advance from the convex side of the great bag of the peritonæum into the cavity of that bag, some more, some less, and also in different manners, as if the sides of a large ball or bladder were thrust inward into the cavity of that ball or bladder.

Of these internal elongations of the peritonæum, some are simply folded like a duplicature; some are expanded like inverted bags, or sacculi, to contain some viscus; some begin by a simple duplicature, and are afterward expanded into a cavity which contains some organ; some are alternately extended in the form of simple duplicatures and of cavities; and, lastly, some form only a small eminence on the inner surface of the great cavity of the peritonæum.

Under the first species of these productions, we may bring the membranous ligaments of the abdomen, such as those of the liver, colon, &c. We see the second species in the external membrane of the liver; the third in the mesentery; the fourth in the mesocolon; and the fifth at the kidneys and ureters.

Besides the external productions of the cellular substance of the peritonæum, it has the same number of internal elongations with the true lamina; which lie between all the duplicatures, and line the insides of all the cavities, or that side next the viscera contained in them.

The uses of the peritonæum, in general, seem to be very evident from the description which has been given of it: and the chief of them are, to line the cavity of the abdomen, to invest

the viscera contained in that cavity as in a common bag, to supply them with particular coats, to form productions, ligaments, connections, folds, vaginæ, &c. as we shall see hereafter.

The fine fluid which transudes through the whole internal surface of the peritonæum prevents the inconveniences which might arise from the continual frictions and motions, to which the viscera of the abdomen are exposed, either naturally or by external impulses.

We must here observe, that it is the common custom to demonstrate four ligamentary ropes, termed the *umbilical vessels*, before the peritonæum is opened, because they adhere to the umbilicus; and three of them are really vessels in the fœtus, viz. two umbilical arteries and one vein. We are in a manner obliged to submit to this custom in public anatomical demonstrations, where we have but a few subjects; but as we are here under no such necessity, we refer the description of these ligaments to other more proper places.

It is sufficient to observe here in general, that three of these umbilical ropes or ligaments are involved separately, and sustained by a production or duplicature, which the peritonæum sends into the cavity of the abdomen in form of a falx.

STOMACH.

Situation and figure of the stomach. The stomach is a great bag or reservoir, situated partly in the left hypochondrium, and partly in the epigastrium.

The figure of the stomach is oblong, incurvated, large, and capacious, at one end, and small and contracted at the other. We see this figure most evidently when the stomach is moderately filled with air or with any other fluid.

The curvature of the stomach gives us occasion to distinguish two arches in it; one large, which runs along the greatest convexity; and one small, directly opposite to the former. These arches are named the *great* and *small* curvatures of the stomach; and by the sides of the stomach, we understand the two lateral portions which lie between the two arches.

The stomach has two extremities; one large and one small. It has two openings, called the *orifices of the stomach*; one between the great extremity and the small curvature, the other at the end of the small or contracted extremity. The first opening is a continuation of the œsophagus; the other joins the intestinal canal, and is called by the name of *pylorus*.

The stomach is not situated in the left hypochondrium and epigastric region, in the manner represented in most figures. It lies transversely, obliquely, and almost laterally; in such a manner as that the great extremity, and the orifice next it, are on the left hand; and the small extremity, with its orifice, or the pylorus, on the right hand, and lower and more inclined than the former: therefore we ought, with the ancient anatomists, to call one of these orifices *superior*, the other *inferior*.

The great extremity of the stomach is in the left hypochondrium, and for the most part immediately under the diaphragm: yet the superior orifice is not in the left hypochondrium, but almost opposite to, and very near the middle of, the bodies of the lowest vertebræ of the back.

The small extremity of the stomach does not reach to the right hypochondrium. It bends obliquely backward toward the upper orifice: so that the pylorus lies about two fingers breadth from the body of the vertebræ immediately under the small portion of the liver; and consequently lower down, and more forward, than the other orifice by almost the same distance. This extremity of the stomach has sometimes a particular dilatation on the side next the great curvature.

According to this natural situation, the stomach, especially when full, is situated with its great curvature forward and a little downward, and its small curvature backward and a little upward.

One of the lateral convex sides is turned upward, the other downward; and not forward and backward as they appear in dead bodies, where the intestines do not support them in their natural situation.

If we divide the stomach along the two curvatures into two equal parts, we shall see that the two orifices do not both adhere to the same half of this division, as we would be apt to

imagine according to the common notion; but that the diaphragmatic orifice is entirely in the upper half, and the intestinal orifice in the lower.

Therefore the body of the stomach is so far from lying in the same plane with the œsophagus, as it is commonly represented in figures drawn from a stomach taken out of the body and laid upon a table, that it forms an angle or fold immediately at the passage of the œsophagus through the small muscle of the diaphragm; and it is on account of this angle that the superior orifice is turned backward.

Structure of the stomach. The stomach is composed of several parts; the chief of which are the different strata which form its substance, to which anatomists give the name of *tunicæ* or *coats.* These coats are commonly reckoned four in number; the outer or common, the fleshy or muscular, the nervous or aponeurotic, and the villous or inner coat; and they are afterward subdivided several ways.

The first or outermost coat is simply membranous, being one of the internal productions of the peritonæum. This appears evidently at the connection of the superior orifice with the diaphragm, where the external membrane of the stomach is really continuous with the membrane which lines the inferior surface of the diaphragm; and it is from this that it has been named the *common coat.*

The second or *muscular coat* is made up of several planes of fibres, which may all be reduced to two; one external, the other internal. The external coat is longitudinal, though in different respects following nearly the direction of the curvatures and convexities of the stomach; and the internal plane is transversely circular.

The fibres of the external plane run slanting in several places; and are intersected by small oblique whitish lines, which seem to be in some measure tendinous. This plane is strengthened by a particular fasciculus which runs along the small curvature, its fibres appearing to be less oblique than those of the great plane.

The fibres of the inner or circular plane of this muscular coat are stronger than those of the outer plane. They are rather seg-

ments which unite at different distances, than entire circles; and they are likewise intersected by great numbers of small white lines, in some measure tendinous and very oblique, which all together represent a kind of net-work, the areolæ or meshes of which are very narrow.

As these circles or segments advance on the great extremity of the stomach, they diminish gradually, and form a kind of muscular vortex; the centre of which is in the middle of that extremity.

Between the outer and inner planes, round the superior orifice, there are two distinct planes about the breadth of a finger, and very oblique, which surround this orifice in opposite directions, and intersect each other where they meet on the two lateral sides.

Along the middle of each lateral side of the small extremity, there runs a tendinous or ligamentary flat portion, above a quarter of an inch in breadth, which terminates in the pylorus. These two portions lie between the common and muscular coats, and adhere very strongly to the first.

Between the two same coats, there is a cellular substance which adheres very closely to the external coat, and insinuates itself between the fleshy fibres of the second, all the way to the third, as may be perceived by blowing it up. Some make it a distinct coat, and call it tunica cellulosa; but it is no more than the cellular portion of the membranous coat, like the cellular portion of the peritonæum.

The third coat, commonly called *tunica nervosa*, but properly *tunica cellulosa*, is composed of capillary vessels and nerves, with a very large proportion of cellular substance. On the concave side it seems to be of a very loose spongy or filamentary texture, resembling fine cotton, as may be seen by macerating it a little in clear water, which swells it considerably in a very short space of time. It is supported by a kind of ground work of a very fine ligamentary or aponeurotic filaments which intersect each other obliquely, much in the same manner as the third coat of the intestines, of which hereafter; and it adheres to the convex side of the villous coat.

The fourth coat of the stomach has been termed by Fallopius

tunica villosa, because, when it swims in clear water, something is seen in it like the pile of velvet. The ancients called it tunica fungosa; and perhaps this name agrees best with its true structure.

These two coats are of a larger extent than the two former, and they join in forming large rugæ on the concave surface of the stomach; the greatest part of which is transverse, though irregular and waving. There are likewise some longitudinal ones which intersect the others; but at the pylorus they all become longitudinal, and terminate there.

At the superior orifice of the stomach, these rugæ are in a manner radiated, and seem to be a continuation of the plicæ or folds of the œsophagus; only they are thicker; and where these rugæ and plicæ meet, they form a sort of crown, which distinguishes the superior orifice of the stomach from the inferior extremity of the œsophagus.

In the interstices of these rugæ, there is often found a sort of slimy mucus, with which the whole cavity of the stomach seems likewise to be moistened. This mucus, which is termed *succus gastricus* or *stomachicus*, is much more fluid in living than in dead bodies, and has been supposed by Winslow, Leber, &c. to be supplied by small glands situated in the substance of the stomach. But Morgagni and Haller have seldom seen such an appearance; and Sabatier observes, that when such an appearance is met with, it may be considered as the effect of disease, and that nothing is more doubtful than the existence of glands in this place.

On the inner surface of the small extremity of the stomach, at the place where it ends in the intestinal canal, we observe a broad, thin, circular border, with a roundish hole in the middle, This hole is the inferior orifice of the stomach, called by the Greeks *pylorus*, which signifies a porter.

This border is a fold or duplicature of the two inner coats of the stomach, the nervosa and villosa; and it is formed in part by a fasciculus of fleshy fibres fixed in the duplicature of the tunica nervosa, and distinguished not only from the other fleshy fibres of the extremity of the stomach, but also from those of the intestines, by a thin, whitish circle, which appears even

through the external or common coat, round the union of the stomach and intestines.

The figure of the pylorus is that of a ring, transversely flatted; the inner edge of which, or that next the centre, is turned obliquely toward the intestines. This inner edge runs naturally more or less into little plaits or gathers, like the mouth of a purse almost shut; all which particulars are very different from what figures and dried preparations would make us believe. It is therefore a kind of sphincter, which can contract the inferior orifice of the stomach, but seems not capable of shutting it quite close.

From the frequent ramifications and communications of the arterial arches of the stomach, two different reticular textures arise; whereof one, which is the largest, lies between the common and muscular coats in the cellular substance found there; the other, which is very fine, lies on the surface of the tunica nervosa. This latter is a production of the first, being formed by means of a great number of very short rami, which go out from the other, and pass through the small interstices between the fibres of the muscular coat.

By artificial injections we can show a third extremely fine reticular texture of capillary vessels, which run between the glandular bodies and papillæ of the tunica villosa. These do not seem in the natural state to be purely blood-vessels, as inflammations and injections may incline us to think.

Uses of the stomach. The stomach receives in general whatever the mouth and tongue send thither through the canal of the œsophagus: but its particular use is to receive the aliments; to contain them for a longer or shorter time, in proportion as they are more solid or fluid; and to digest them, that is, to put them in a condition to be turned into that nutritious fluid called *chyle.*

This operation, which goes by the general name of *digestion,* and by which chylification begins, is performed partly by the succus gastricus, which flows continually from the tunica villosa, and partly by the continual contraction and relaxation of the muscular coat. These motions in men are but very weak, and nowise sufficient for digestion, without the assistance of

the alternate motions of the diaphragm and muscles of the abdomen.

The pylorus, or fleshy circle of the inferior orifice of the stomach, serves to retain the aliments in it, till they have acquired a sufficient degree of fluidity, to pass easily through that opening. But by a particular irritation of the muscular coat of the stomach, and still more by a violent contraction of the diaphragm and muscles of the abdomen, the contents of the stomach may be very soon forced toward the small extremity, and pushed through the pylorus.

The gentle and alternate motions of the orbicular fibres of the muscular coat may assist in sending through the pylorus, in the natural way, the aliment that is sufficiently digested. This was called the *peristaltic* or *vermicular motion*, by those who believed that it is successively reiterated, like that of earthworms when they creep.

Trituration might be a proper enough term for this operation, provided it be made to signify only a gentle agitation or action of the fleshy fibres in a substance continually moistened by the gastric liquor, and not a violent grinding of a dry substance.

The situation of the stomach, which is nearly transverse, is likewise of use in making the aliment remain long enough in that cavity; and may serve to make the length of this stay, in some measure, arbitrary, by means of the different postures of the body; for when we lie on the left side, the aliment must remain longer than when we lie on the right, &c.

THE INTESTINES IN GENERAL.

Situation, size, and division of the intestines. Between the pylorus and the very lowest part of the abdomen lies a long canal, bent in a great many different directions by numerous convolutions, called the *intestines*.

This canal, thus folded and turned, forms a considerable bulk, which fills the greatest part of the cavity of the abdomen; and it is connected through its whole extent to membranous productions or continuations of the peritonæum, principally to those called the *mesentery* and *mesocolon*; of which hereafter.

The incurvations of the intestinal canal form two arches; a small one, by which it is connected to the mesentery and mesocolon; and a great one on the opposite side, which lies loose. The whole canal is generally about six or seven times as long as the subject.

The intestinal canal is neither of an equal size or thickness through its whole length; whence anatomists have taken occasion to consider its different portions as so many particular intestines, and to divide them all into small and great.

And as they still found some differences in each class taken altogether, they divided each into three portions, which they distinguished by particular names. In the small intestines, the three portions are named *duodenum*, *jejunum*, and *ileum;* and in the great intestines, *cæcum*, *colon*, and *rectum*.

Structure of the intestines. The intestines in general are composed of several coats, much in the same manner with the stomach. The first and outermost is a continuation of the mesentery, or of some other elongation or duplicature of the peritonæum.

This is commonly termed the *common coat;* and it has a cellular substance on its inner surface, like that of the stomach, which M. Ruysch thought fit to call a distinct coat by the name of tunica cellulosa.

The second coat of the intestines is fleshy or *muscular*, and made up of two planes; one external, the other internal. The external plane is very thin, and its fibres longitudinal; the internal plane is thicker, and its fibres run transversely round the circumference of the intestinal cylinder.

It would appear that these fibres are neither spiral, nor do they form perfect circles; but seem rather to be segments of circles, disposed much in the same manner as in the stomach, and thus surrounding entirely the intestinal canal.

These two planes adhere closely together, and are separated with great difficulty. They adhere likewise to the common coat by the intervention of the cellular substance, which is in greater quantities on the side next the mesentery than on the other.

The third coat is called the *nervous*, and is something like that of

the stomach. It has a particular plane, which serves as a basis to sustain it, made up of very fine strong, oblique fibres, which seem to be of the ligamentary or tendinous kind.

To see this plane distinctly, a portion of the intestines must be inflated, the common coat removed, and the fleshy fibres scraped off.

This coat sustains two reticular substances, which are both vascular, one arterial, the other venal, accompanied by a great number of nervous filaments. These vessels and nerves, productions of the mesentric, as they surround the whole canal of the intestines, have been called by the name of tunica vasculosa.

The nervous coat sends off from its inner surface a great number of portions of septa, more or less circular, which contribute to the formation of what are called *valvulæ conniventes;* of which hereafter. It likewise seems to sustain several different glandular bodies, which we discover in the cavity of the intestines.

The fourth or innermost coat is very soft, and is named *tunica villosa.* It has the same extent with the third coat, which supports it; and it lines all the septa of that third coat; but it is not uniform through the whole canal, as we shall show in the particular description.

It is now generally believed, that the fourth coat is a continuation of that in the stomach, and, of consequence, from the epidermis.

THE SMALL INTESTINES IN GENERAL.

The small intestines form one continued uniform canal; and although three portions of it have three different names, yet we have no sufficient marks whereby to distinguish them, to fix the precise extent or length of each portion, or to settle its just limits.

The first and smallest portion of the whole canal is called *duodenum*; the second, which is much longer, *jejunum;* and the third, which is still longer than the second, *ileum.*

DUODENUM.

The first portion of the small intestines was called *duodenum*, from the length ascribed to it by the ancients, viz. the breadth of twelve fingers.

This intestine having arisen from the pylorus, is immediately bent a little backward and obliquely downward; then it bends a second time toward the right kidney, to which it is a little connected; and thence passes before the renal artery and vein, ascending insensibly from right to left, till it gets before the aorta and last vertebræ of the back. It continues its course obliquely forward by a gentle turn, which may be reckoned a third incurvation, and also the extremity of the duodenum.

Through this whole course the duodenum is firmly bound down by folds of the peritonæum, especially by a transverse duplicature which gives origin to the mesocolon. The two laminæ of this duplicature being at first separate, and soon afterward uniting, must leave a triangular space between them, which is lined with a cellular substance.

It is in this space that the duodenum adheres by means of the cellular substance to the parts already named; and the intestine is contained therein, as in a case; so that, without dissection, we can see nothing but its two extremities; and even these are hid by the colon, and by the first convolutions of the jejunum.

Structure of the duodenum. The first coat of the duodenum is consequently different from that of the other small intestines, having this peculiar to it, that it does not invest the whole circumference of the intestine; because, through the greatest part of its length, it lies in the triangular space already mentioned; and, for the same reason, there is a greater quantity of cellular substance belonging to the outer coat of the duodenum than to that of the other intestines.

The muscular coat of the duodenum is thicker than in the jejunum and ileum.

The tunica nervosa and villosa form conjointly, on the insides of this intestine, a great number of small duplicatures, which

advance into the cavity more or less directly, like portions of circular planes, with one edge fixed to the intestine, and the other loose. These are what anatomists call *valvulæ conniventes.*

The loose or floating edge of these valves is formed into small gathers or waves in the natural state. The whole surface of these duplicatures or valves is villous, as well as that of the intestines between them.

The villi of this intestine are thicker than in the stomach; but the texture of them in man is not like hairs, as they are commonly represented in figures, but rather like that of a fungous, granulated substance, composed of an infinite number of very fine papillæ of different forms; in which we see, through a microscope, a multitude of depressed points or pores, by which their whole surface seems to be pierced.

By the same help we observe, on different places of the inner surface of this intestine, several round villous tubercles, rising like small verrucæ at different distances from each other.

This substance sustains an infinite number of capillary vessels of different kinds; for besides the blood-vessels, we sometimes observe a great number of white filaments which run through it and end at its inner surface like so many capillary roots, of the vessels called *venæ lacteæ.* When the villous substance is examined in the microscope, besides the blood-vessels, numerous follicles are observed lodged in cellular substance. These have been considered as the origin of the lacteal vessels, and have been called *ampullulæ of Leibercuhn*, because he first discovered them.

The fungous substance which binds these capillary filaments together, and surrounds them, is very tender; and the capillary extremities of the small blood-vessels distributed through it, seem to be turned toward the pores of the papillæ. Through these pores a mucous fluid, more or less transparent, is discharged, which continually moistens the cavity of the intestine.

Glands of the duodenum. The internal surface of the duodenum is furnished with a great number of small flat glandular tubercles, named after Brunner, which are raised on the sides, nd depressed in the middle by a kind of fossula; and they are

more numerous near the beginning of this intestine than any where else. About the pylorus they lie in a manner in heaps or clusters; and thence the distance between them increases gradually all the way to the other extremity where they are single.

These glands, when examined carefully, appear like little bladders, with the orifices turned toward the cavity of the intestine, and the bodies fixed in the spongy substance next the nervous coat. They furnish a particular fluid, which is often found to be viscid.

The biliary orifice of the duodenum. In the inner surface of the duodenum, almost at the lower part of the first incurvation, and on the shortest side, there is a longitudinal eminence; in the point or apex of which lies a particular opening, which is the orifice of the ductus biliarius, within which the ductus pancreaticus likewise opens.

This intestine is commonly the widest, though the shortest, of the intestina tenuia, and has been called by some ventriculus succenturiatus; it is invested by more cellular substance, especially while within its triangular case, where it wants the outer coat which the others have; and consequently it is more easily dilatable by the substances which might otherwise stick within it.

JEJUNUM.

Situation and size of the jejunum. The jejunum, so called, because it is oftener found empty than the ileum, begins at the last incurvation of the duodenum, and is there connected to the beginning of the mesocolon.

Thence it bends downward from left to right, and obliquely forward, or from the vertebræ, and makes several convolutions, which lie chiefly in the upper part of the umbilical region. Through all this course it is connected to the mesentery, in the manner that shall be explained hereafter.

It is a pretty difficult matter to fix the exact bounds between this intestine and the ileum. The external marks of a redder colour in the one than in the other, though pretty common, are

not constant; and the internal marks fixed from the plurality of valvulæ conniventes are indeterminate, and oftentimes appear only from dissection.

These two intestines may be better distinguished by their different situations, which are pretty regular; but as even this mark is not particular enough, the most easy way, and which will in most cases be found sufficiently exact, is to divide both intestines into five parts; and to allow nearly two-fifths to the jejunum, and three-fifths and a little more to the ileum.

Structure of the jejunum. The coats of the jejunum are nearly of the same structure with those of the duodenum, but thinner. The common coat is a continuation of the mesentery; and the cellular substance is in less quantity than in the duodenum, and indeed seems to be altogether wanting along the great curvature of the convolutions, where the longitudinal fibres of the muscular coat adhere very closely to the external membrane.

This muscular coat is not so strong as that of the duodenum. The longitudinal plane of fibres is very thin, and almost imperceptible, except along the great curvature, opposite to the connection of the mesentery, where we see, through the membranous coat, a kind of whitish ligamentary band, about the third part of an inch in breadth, which is continued along the great curvature of all the convolutions of this intestine, and of the ileum.

This ligamentary band is like those which we observe on the sides of the small extremity of the stomach. It adheres perfectly to the membranous coat, and to the longitudinal fibres of the muscular which are here more visible, and appear to be stronger than in any other place.

The tunica nervosa, which we choose rather to call *reticularis*, and its proper cellular or lanuginous substance, have nothing peculiar to them more than has been already said about the intestines in general. By blowing artfully into this substance, it may be made to swell so much, round the whole cavity of the intestines, as to destroy all the duplicatures or valvulæ conniventes.

These valves in this intestine are very broad, very numerous,

and very near each other. On the side of the great curvature, their circumference is continuous and uniform; but next the small curvature, there are several breaks in them, the extremities of some advancing beyond the rest, and terminating in points. Some of these valves go quite round, others only some part of the way; and some of them are very small, which go obliquely between two large ones, forming a kind of communication.

The papillæ of the tunica villosa are here more raised, more loose and floating, than in the duodenum; and each of them seems to be divided into several others, by incisures of a very singular kind. In other respects they agree pretty much with what was said in the description of the intestines in general.

The glandular lacunæ of the jejunum are of the same structure with the glandulæ Brunneri or duodenales; but they are disposed in a different manner. They are partly single, at different distances from each other; and partly in several clusters, like flat oblong bunches of grapes, called *plexus glandulosi Peyeri*. These are in the largest quantity near the great curvature, and they cross through several valvulæ conniventes at once.

ILEUM.

Situation of the ileum. The convolutions of this intestine surround those of the jejunum on the two lateral and lower sides, and it passes in a winding course from the left side, by the hypogastrium, to the right side, where it terminates a little below the right kidney, joining the intestina crassa, in the manner that we shall relate hereafter. The lateral convolutions are supported by the ossa ilium, so called, not from this intestine, but from the regions of the abdomen, termed *ilia*.

Structure of the ileum. The structure of the ileum is much the same with that of the jejunum; only the internal duplicatures or valvulæ conniventes decrease gradually both in number and size. Near the extremity of the ileum their direction is changed; and instead of being transverse or circular, they be-

come longitudinal, and terminate in a kind of pylorus, which advances into the cavity of the great intestines, as we shall see presently.

We observe likewise in this intestine, as in the jejunum, single glands or lacunæ, and also reticular glands in clusters; the last of which, at the extremity of this intestine, is oftentimes of a great extent: but the greatest part of these glands appear to be flatter here than in the jejunum. The cellular substance of the external coat is in less quantities than in the foregoing intestines; and the ileum appears commonly more pale, or not so red as the jejunum.

Sometimes, though rarely, we meet with processes sent off from the jejunum or ileum, and of the same structure with these intestines. Their form, being similar to that of the finger of a glove, appears to have given them the name of *appendices digitales*. They are mentioned by different anatomists, and have sometimes been found to form true herniæ.

THE LARGE INTESTINES IN GENERAL.

The great intestines are one continued canal, divided into three portions, like the small ones. This canal begins by a kind of sacculus or bag, which is reckoned the first of the three portions, and called *cæcum*. The second portion, called *colon*, is the longest of the three; and is distinguished from them by a great number of particular eminences or convexities, which appear on its outer surface through its whole length. The last portion is named *rectum;* being more uniform, narrower, thicker, and much shorter, than the colon.

The structure of the great intestines is nearly the same with that of the small ones, in regard both to the number and disposition of their coats. They are shorter, and have fewer convolutions, but are much more capacious. The coats in general are stronger, but especially the muscular coat. The villi and mucilaginous glands are different; and there are several other things relating to them, which will come in better in the particular history.

CÆCUM.

Situation and structure of the cæcum. The intestinum cæcum is only a round short broad bag, the bottom of which is turned downward, and the mouth or opening upward. It lies under the right kidney, and is hid by the last convolution of the ileum. It has nothing to distinguish it from the colon, excepting that it is a little wider, is shut at its under end, and gives origin to the appendicula vermiformis.

Appendicula vermiformis. On one side of the bottom of the cæcum lies an appendix, resembling a small intestine, nearly of the same length with the cæcum, but very slender. It is termed *appendicula vermiformis*, from its supposed resemblance to an earthworm. Its common diameter is not above a quarter of an inch. By one extremity it opens laterally and a little obliquely into the bottom of the cæcum; and the other extremity is closed, being sometimes greater sometimes smaller than the rest of the appendix.

It has some contortions, like those of a worm when it is touched, from whence comes the epithet of *vermicularis* or *vermiformis*. Its structure resembles nearly that of the other intestines.

The internal coat of this appendix is folliculous, like that of the duodenum; and it is likewise reticular, the meshes being the glandular lacunæ, which continually discharge a fluid into its cavity.

It has been often disputed whether this appendix, or the large portion, which is, as it were, the head of the colon, ought to be called the *cæcum*; but the general division of the intestines into great and small, leaves no room to doubt of its being only an appendix in man, whatever reason there may be for talking differently with respect to brutes and birds.

Through the membranous or common coat of the cæcum, we see three white muscular ligamentous-looking bands, which adhere very closely both to the outer and muscular coat. One of them is hid by the adhesion of the mesocolon; and all the three

divide the cæcum longitudinally into three parts more or less equal.

They all unite on the appendicula vermiformis, and cover its whole outer side immediately under the common coat. Though they appear exteriorly on the cæcum to be ligamentary, they are made up interiorly of fleshy fibres which accompany and strengthen the longitudinal fibres of the muscular coat.

The villous substance of the inner coat of the cæcum is very short, and furnished in several places with glandular lacunæ or solitary glands, broader than those of the small intestines.

These glandular lacunæ or folliculi are flattened and depressed in the middle like smallpox. When we blow through a pipe into these lacunæ without touching them, the folliculi are inflated, and represent little caps with a hole in the middle of their convex side.

COLON.

Situation and structure of the colon. The colon is the most considerable of all the intestines. From the cæcum, of which it is a continuation, it reaches, in form of an arch, above the umbilical region, and to the lower part of the left hypochondrium. Its continuity is, however, a little interrupted by the ileum, which advances into the cavity of the colon, and, together with a certain fold of that intestine, forms what is called *valvula coli.*

The whole convex side of the colon is divided longitudinally into three parts, by three muscular bands, first known to Sylvius and Eustachius, continued from those of the cæcum, and of the same structure with these. Two of those bands run on each side along the great curvature of the colon ; and the third along the small curvature.

The uppermost band of the two that belong to the great curvature, is the broadest of the three ; that which belongs to the small curvature is the narrowest, and lay hid by the connexion of the mesocolon, till discovered by M. Morgagni.

These three longitudinal bands do the office of fræna, between which this intestine is through its whole length

alternately depressed into transverse folds, and raised into considerable éminences. All the folds are duplicatures, which form portions of valvulæ conniventes in the cavity of the intestine; and the eminences form receptacles, called the *cells of the colon.*

All the coats of the colon concur equally to the formation of these duplicatures and cells, the depth of which decreases gradually toward the extremity of the intestine, and neither of them go any further than the ligamentary bands.

These portions of the colon which are immediately covered by the ligamentary bands, are smooth and without rugæ; and therefore, if these bands alone are cut across, the intestine is not elongated sufficiently to destroy all the folds and cells.

The common coat on one side is a continuation of the mesocolon, and on the other side it contributes, by similar continuation, to form the omentum. The longitudinal fibres of the muscular coat are very slender; excepting in the bands already mentioned; and those which answer to the annular or circular fibres of the small intestines, are only segments stretched over the eminences and folds. The other coats are nearly as in the cæcum; only the glandular lacunæ or solitary glands are broader and more numerous.

The arch of the colon begins under the right kidney, near the haunch. It runs up on the foreside of that kidney to which it is connected; passes under the vesicula fellis, which tinges it with a yellow colour at that place; and continues its course before the first incurvation of the duodenum, to which it adheres, and partly hides it. In this part of its course, therefore, there is a remarkable connection between the colon, duodenum, right kidney, and vesicula fellis.

Thence the arch of the colon runs before the great convexity of the stomach, and sometimes a little lower; then turns backward under the spleen, in the left hypochondrium; runs down on the foreside of the left kidney, to which it is connected; below this kidney, turns toward the vertebræ, and terminates there by a double incurvature, or by two opposite convolutions, which represent in some measure an inverted Roman S.

These last convolutions of the colon are sometimes multiplied, and even advance to the right side of the pelvis; and along the great arch, and the two last incurvations, there are a kind of fringes, called *appendices coli adiposæ*, which we shall afterwards explain, as also the connections of the colon with the mesocolon and omentum.

Valvula coli. At the place where the cæcum joins the colon, one portion of the circumference of both is depressed, and forms a large fold on the inside, which advances into the cavity of the intestine, and gets the name of *valve* of the *ileum*, of the *cæcum*, or of the *colon*. Some have named it after Bauhin, who was said to discover it accidentally at Paris in 1579, by throwing water into the intestines, and finding that the passage was obstructed at the end of the ileum; but Vidus Vidius has described it several years before this. It is a little open in the middle, and its extremities are very thick, by reason of the mutual duplicature of the coats of the cæcum and colon.

The extremity of the ileum is as it were grafted in the opening of this fold, and strongly united to its sides by the adhesion of its transverse fibres to the transverse fibres of the cæcum and colon.

This union forms a pretty thick ring, which likewise advances into the common cavity of the cæcum and colon, where it is wrinkled, almost like the lower extremity of the œsophagus, the pylorus, or inside of the anus. Its circumference is more or less oval; and, by a kind of continuity with the common fold of the cæcum and colon, it forms two productions, which M. Morgagni calls the *retinacula valvulæ Bauhini*.

The membranous coat of the extremity of the ileum is continued on the cæcum and colon, without sinking into any fold at the place where the ileum enters the colon. The longitudinal fibres of the muscular coat seem here to be confounded with the nearest circular fibres of the cæcum and colon.

The inner portion of the muscular coat of the ileum runs in between the circular fibres of the ileum and colon, as into a common fold of these two intestines; from all which a pretty thick short portion of a fleshy tube is formed, which is the circular rising already mentioned.

The tunica nervosa and villosa of the extremity of the ileum likewise enter the common cavity of the cæcum and colon, and on the edge of the circular rising join the like coats of these two intestines; so that the circular rising or short muscular tube is covered both on the outer and inner sides by a nervous and villous coat; that on the inside being supplied by the ileum, and the other by the two great intestines.

The situation of this extremity of the ileum is most commonly transverse, and is inserted almost in the same direction into the common cavity of the two intestines already mentioned; but it is often a little more inclined toward the cæcum than to the colon; and whereas in all other places the ileum is wide and easily dilatable, it is very narrow at its insertion, and its sides are more solid and firm.

It is chiefly in this structure that the mechanism of the insertion of the ileum in the cæcum and colon consists; about which insertion or opening, authors are very much divided, some reckoning it a valve, others only a spincter.

It is very evident, from what we have said, that it is a double machine contrived to hinder the return of the excrements into the ileum, because it can produce this effect partly as a valve, and partly as a kind of sphincter. The dried preparations of this part give a very false idea of its structure and conformation; and the same thing is to be said of the opening of the appendicula vermiformis into the cæcum.

The capacious arch of the colon is connected by both extremities to the regio lumbaris, near the kidneys, by two particular ligaments, one on the right side, the other on the left, which are only small duplicatures of the peritoneum, more or less transverse.

The remaining portion, which forms the two convolutions in form of the Roman S, contracts below the left kidney, being narrower there than lower down. The coats of this portion become gradually thicker and stronger, and likewise the ligamentary bands, which approach each other by degrees, and seem to increase in breadth.

RECTUM AND ANUS.

Situation, figure, and size of the rectum. The last of all the intestines is named *rectum*, or the *straight gut*, from its situation; for, when viewed directly forward, it sppears to run down in a straight course from the last vertebra of the loins, on the foreside of the os sacrum, all the way to os coccygis, where it ends in what is called the *anus*.

This intestine, properly speaking, is a true continuation of the last convolution of the colon; and it is the common sewer of the whole intestinal canal. It has likewise a special relation to the bladder, and to the parts of generation in both sexes.

The rectum having passed below the last vertebra of the loins, to the inside of the os sacrum, is bent backward on that concave side, to which it is connected, in the manner that shall be afterward explained; and having reached the os coccygis, it runs likewise in the direction of that bone, and bends a little forward, terminating beyond the extremity of the coccyx.

The figure of this intestine varies according as it is full or empty. When empty, it is irregularly cylindrical, and sinks in by a kind of transverse folds; and in that state, it is about three fingers breadth in diameter. When full, it is wider in proportion to the quantity of fæces, wind, or whatever else is contained in it; and it may be extended to the size of a large bladder.

Structure of the rectum. The membranous coat often contains a great quantity of fat, spread between it and the muscular coat, and forming round the intestine numerous eminences, in the room of the appendices adiposæ of the colon, which shall be explained in the history of the omentum.

The muscular or fleshy coat is very thick; and the longitudinal fibres, which in the other intestines are very thin, are in this stronger than the circular fibres of the rest. The ligamentary bands continue to increase in breadth, and to approach each other, as has been said; and it is to the fleshy fibres of these bands that the thickness of the longitudinal fibres seems to be owing.

The nervous or filamentous and internal coats, are larger here than in the other intestines; and when the rectum is empty, they form a great number of waving rugæ in its cavity, which disappear in proportion as that cavity is filled.

The innermost coat is very improperly termed *villosa*, and scarce deserves the name of *papillaris*, because of the smallness of the little corpuscules spread on its surface. It contains a great number of solitary glands; and it is always moistened by a mucous of different consistences, discharged by these glands or folliculi, and perhaps by the corpuscles also.

Near the extremity of this intestine the rugæ or folds become in a manner longitudinal; and at last, towards the circumference of the inner margin of the anus, they form little bags or semilunar lacunæ, the openings of which are turned upward, toward the cavity of the intestine. These lacunæ are something like those of the lower extremity of the œsophagus, or upper orifice of the stomach.

Anus. At length the extremity of the rectum contracts, and terminates by a narrow orifice called the *anus*, the sides of which are disposed in close folds. This extremity of the intestine has several muscles belonging to it, some of which surround it like sphincters; the rest are broad fleshy planes inserted in it, and which, being likewise fixed to other parts, sustain it in its natural situation, and restore it to that situation after being disturbed by the force necessary for the exclusion of the fæces. These latter muscles are termed *levatores;* the first are the *sphincters.*

MESENTERY AND MESCOLON.

Division of the mesentery, &c. This great bundle of intestines is not left to move at random in the cavity of the abdomen; but artfully bound down by a membranous web, which prevents the intestinal convolutions from being entangled in each other, and from being twisted or compressed in all their different ways of meeting; and yet allows them a gentle floating, but limited, motion.

This web goes still by the ancient Greek name of *mesentery*, as being in some measure in the middle of the intestines. It is distinguished into two portions; one of which being very broad and very much plaited, connects the small intestines; the other, which is long and incurvated, does the same office to the great intestines.

These two portions are in reality one and the same continuation of the membranous lamina of the peritonæum doubled back upon itself, and they are distinguished only by their breadth. Taken both together, they form a kind of spiral roll, more or less plaited in its circumference. The first portion has retained the name of *mesentery*, the other is termed *mesocolon*.

Structure of the mesentery, &c. The mesentery begins at the last incurvation of the duodenum, and runs obliquely from left to right, along the vertebræ of the loins. In this space, the membranous portion of the peritonæum is detached on both hands, produces a duplicature by two elongations or particular laminæ applied to each other, and thus forms the mesentery.

It is narrower at its upper and lower parts, but chiefly at the upper. The middle portion is very broad, and the edge of it next the intestines is every where very much plaited. These plaits or folds are only waving inflections, such as may be observed in rhe edge of a piece of shamoy which has been often drawn through the fingers. They make this edge of the mesentery very long, and they run through about one third of its breadth.

The two laminæ are joined together by a cellular substance, which contains glands, vessels, and nerves; and in some subjects it has a great quantity of fat, which keeps the two laminæ at a good distance from each other.

Along the whole circumference of the mesentery, the two laminæ are naturally separated, and applied to the two sides of the small intestines, which they invest by their union or rather reciprocal continuation on the great curvature of that canal, and carry it as in a scarf or sling. This is what forms the external or membranous coat of the intestines.

The mesocolon is the continuation of the mesentery; which having reached the extremity of the ileum, contracts and changes

its name. At this place, the particular lamina which is turned to the right side, forms a small transverse fold, called *ligamentum coli dextrum.*

Afterward the mesocolon ascends toward the right kidney, where it seems to be lost by the immediate adhesion of the colon to that kidney, and to the first incurvation of the duodenum. Then it appears again, and increasing in breadth, it continues its course almost transversely under the liver, stomach, and spleen, where it begins to turn downward, under the left hypochondrium, toward the kidney on the same side.

Through this whole course the mesocolon extends in breadth, and forms nearly a transverse semicircular plane, very little plaited at its great circumference. By this circumference or edge, it is connected to the colon, and hides that ligamentary band of this intestine, which runs along its small curvature. By its short or small edge, it forms the triangular case of the duodenum; and, by its great edge, the external coat of the colon, in the same nanner as the mesentery does that of the small intestines. As it passes under the large extremity of the stomach, it adheres a little to the lower portion of that extremity, as the diaphragm does to the upper.

Having got below the left kidney, it contracts, and forms another transverse fold, called *ligamentum coli sinistrum.* Afterwards it expands again, but not so much as in the upper part; and runs down on the left psoas muscle, toward the last vertebra of the loins. This descending portion is fixed to the convolutions of the colon, in the same manner as the superior portion is to the arch of that intestine.

The rectum is likewise invested by a particular production of the peritonæum, called commonly by the name of *meso-rectum.* This production is very narrow; and about the middle of the foreside of the rectum, it forms a transverse semicircular fold, which appears when the intestine is empty, but is lost when it is filled.

Between the laminæ of the mesentery, a great number of glands lie scattered through the cellular substance. In the natural state, these glands are something of the figure of lentils or little round beans, some of them being orbicular, others oval,

but all of them a little flatted, and in corpulent subjects we find them surrounded with fat.

These glands are of the number of those that anatomists call *glandulæ conglobatæ*, the structure of which is not yet sufficiently known. They seem to be of a cellular substance, surrounded by a very fine membrane or coat, on which, by the help of microscopes, we discover an intertexture, of particular filaments, which Malpighi believed to be fleshy fibres.

The nicest anatomical injections have not hitherto given us any satisfaction about these particulars: for though they be made with all possible care, they always fill the folliculous texture of these glands; and though by means of these injections we may discover a great many vessels, which were before invisible, we are not a whit the nearer our purpose, because we cannot by this method distinguish the secretory, excretory, and blood-vessels from each other.

Besides the blood-vessels, which are distributed in a reticular manner in the mesenteric glands, and besides many nervous filaments spread through them, we discover an infinite number of small vessels of another kind, running from gland to gland.

These vessels are extremely thin and transparent, and furnished on the inside with numerous valves, which appear on the outside like small knots very near each other. They go out from each gland by ramifications, as by so many roots; and having formed a small trunk, they are again divided, and enter some neighbouring gland by the same kind of ramifications by which they went out from the former.

Lacteal vessels. These are also termed *lymphatic vessels*, because for the most part they contain a very clear, limpid, though mucilaginous serum, called *lymph* by anatomists. But as they have likewise been observed to be filled with a white milky fluid, called *chyle*, they have been called *vasa chylifera*, or *venæ lacteæ*. They have the name of *veins*, because their valves are disposed as those of the ordinary blood-veins, and because the fluid which they contain runs from smaller into larger tubes.

DIGESTION.

Within the human stomach we first meet with a great quantity of mucus, spread upon its villous lining; which mucus is not unfrequently tinged by some of the bile returning into the stomach. Besides this, in an empty stomach, upon bending the body, a great quantity of a limpid humour will arise into the mouth, altogether of the same nature with the saliva, but more mucous; which liquor is very rarely to be found pure or unmixed in the stomach. It is very far from possessing any acid acrimony, when it can be had pure from the food. Left to itself, it changes, both in man and brutes, rather to a lixivial or alkaline nature, when it is separated from the acid illuvies of the aliments, more especially in an hungry animal. This liquor distils from the arteries of the stomach, through its villous coat, after the manner we see by anatomical injections.

The stomach then, contained within the abdomen, which is perfectly full, will thence, receive a force or compressure upon its sides, which lie betwixt the diaphragm; the concavity of whose right wing is filled by the liver, under which, and within the left wing, lies the stomach extended almost transversely behind the resisting muscles of the abdomen, viz. the recti and obliqui, but chiefly the transverse. The more the stomach is filled, the more it is urged by this pressure of the abdominal muscles; because, at the same time, it rises upward in a right angle to the contact of the peritonæum.

Since every day there is, in the human body, a great quantity of its substance thrown off by perspiration; reparation of this loss is every way necessary. But this necessity of taking food recurs the more quickly from the nature of the blood itself, which is strongly inclined to a sharp, saline, lixivial quality, and to an acrimonious state: to which last it is continually solicited by the disposition of all the more stagnant humours of the animal, promoted by the incessant motion of the heart and arteries, and by heat, which very much tends to the putrefaction of all the animal humours. Moreover, the coa-

gulable disposition of the blood, continually losing a great part of its diluting water by insensible perspiration, requires a recruit of the watry element, in the way of drink, by which its cohesive globules are separated from each other, and hindered from running together into a consistent mass.

These truths are proved not only from their causes, but likewise by the appearances which they exhibit in animals killed by hunger. For, in such we commonly observe a sharp stinking breath, a looseness of the teeth from the dissolving acrimony of the juices, violent pains in the stomach, sharp fevers, and even madness. All these disorders arise sooner and stronger, as the person is more robust and more violently exercised with motion of body; but they ensue very slowly in phlegmatic people, who are unactive, perspire little, and put the blood into no great motion.

The fresh chyle, composed, for the most part, out of the acescent class of vegetables, and of a consistence always thinner than that of the blood itself, being received into its torrent of circulation, temperates the acrimony, dilutes the threatened coagulation, and reduces the whole mass to that moderate degree of saline nature which is proper to man: and finally, the chyle, but more especially that derived from the flesh of animals, and likewise what is formed of farinaceous vegetables, being replenished with gelatinous lymph, serves to repair the consumption or waste which is made from the body itself, to which it is applied by the causes which promote its growth. The drink dilutes the cohesive inclination of the blood, hinders its putrefaction, and carries off by the emunctories such particles as tend to putrescency: and hence it is, that a person may live for a long time without solid food, if he be supplied with drink; but without drink, life subsists but a few days.

We are solicited to take food, as well from the sense of pain we call hunger, as from that of pleasure, which is received by the taste. The first of these proceeds doubtless from the sensible folds or wrinkles of the stomach rubbing against each other by the peristaltic motion, of which there is an acute sensation, joined with a pressure from the diaphragm and abdominal muscles.

To this sense perhaps the gastric liquor or juice of the stomach does in some measure conduce, unless it tends to putrescency.

Thirst is seated in the tongue, fauces, œsophagus, and stomach. For whenever these very sensible parts, which are constantly and naturally moistened by mucous and salival juices, grow dry from a deficiency of those or the like humours, or are irritated by a redundancy of alkalescent salts here lodged, there arises a sense much more intolerable than the former, as thirst is more dangerous; whose uneasy sense continues until the proportion of diluting water in the blood, being recruited, restores the necessary moisture and free secretion required in the parts before mentioned. Hence we learn, why thirst attends labour, which exhales a greater proportion of the watery perspiration; and why it is a symptom of fevers, where there is an obstruction of the exhaling vessels belonging to the tongue and fauces; why simple water is less efficacious in abating thirst, which yields nevertheless easily to some acid liquors, that not only moisten and render fluid, but also, by their mild irritation of the tongue and mouth, provoke forward the humours, and at the same time correct their putrid tendency.

The food is digested in a heat equal to that of an hatching egg, in a cavity altogether close or confined above, as it also is below, by the ascent of the incurvated pylorus, and in a great measure by a shutting valve, and likewise constringed by the muscular force of the fibres; whence we observe, that even milk itself is often retained in the stomach of strong animals several hours after a meal, without passing into the intestines. These aliments are continually moistened with watery juices, and at the same time are replenished with a good deal of air incorporated with them, either naturally or in the mastication. This air, therefore, expanding by the force of heat, putrefaction, or fermentation, breaks open the cells by which it was included, divides the viscid liquors, and softens or opens the solid fibres, so as to make a way for discharging their juices. While this air is extricated, the aliments by long stay begin to corrupt or change into a nauseous liquid, often acescent; or otherwise putrescent, which however happens less in mankind from the use of bread and salt; or rancescent, as appears from the flatus

and matters eructated, often of a most fetid, caustic, and inflammable nature, from substances of the like disposition. This putrescency, or imperfect putrefaction, says Haller, is almost the only cause of digestion in fish, serpents, and carnivorous birds. Hence, in mankind, metals themselves, by long stay in the stomach, grow soft, and are eroded ; but from Spallanzani's experiments it appears, that there are no signs of putrefaction in the time of digestion, except in sick animals. At the time hunger is absent, the nervous plates of the stomach are removed and defended from contact with each other by the interposed aliment, at the same time that the juice of the stomach itself is less sharp and freer from a mixture with the old remains of the last food.

But that the aliment might not degenerate into a complete acidity, there is a check from the putrescent degree of the heat, the power of the juices distilling from the stomach, and that of the saliva itself, swallowed to the amount of half an ounce in an hour, and rather inclined to an alkalescency : these juices also being ground together with the aliment, macerate, soften, and dissolve the fibres themselves and their cellular bands, leaving them a soft pulp like what we see by letting them stand for a long time in warm water, extract their juice, and mingle it with themselves. There is therefore no particular kind of ferment in the stomach ; from which indeed the design of nature, the disposition of the stomach, and its use, are all very remote. And yet the juice of the stomach alone, by its longer stay in fishes, dissolves the bones which they had devoured.

The fleshy fibres in the stomach being now irritated by the flatus, weight, and acrimony of the food, begin to contract themselves more powerfully than when the stomach is empty, and with a greater force in proportion as it is more full, the round swelling of which stretches these fibres. And, first, the muscular stratum, which passes along the lesser curvature, connects the pylorus with the œsophagus ; and, being inserted only into the left face of the former, draws it to the right. The principal stratum of the circular fibres contracts the capacity of the stomach, according to its length ; grinds or intermixes its contents together with the liquors ; and determines them both to

flow toward the pylorus: but this flux through the pylorus is not made continually on account of the valvula pylori, and likewise because this motion begins from some part that is more irritated; and thence the aliment is driven here upward, as in other parts downward. These alternate contractions at last terminate in a full evacuation. In this action of the stomach, there is nothing which resembles the triture made by the strong gizzards of granivorous fowls, which some anatomists have ascribed to the human stomach; which yet has a considerable degree of strength, since the contraction of its fibres is often more than a third part of their length; for we frequently see the stomach reduced to less than a third of its diameter: frequently also the stomach is observed to be diminished to much less than a third part, even to the breadth of an inch; which, lastly, makes it fit for moving forward sharp-pointed substances. Yet it neither bruises berries nor the softest worms.

But that motion which it receives from the diaphragm and muscles of the abdomen, is stronger than the peristaltic force of the stomach; for, by this, the stomach is more perfectly emptied by a close approximation of its anterior and posterior sides. For it is principally by this force that the drinks are urged on continually, but the foods only when they are dissolved, lest those parts which are too gross should be expelled through the pylorus into the duodenum, when the stomach is more that way inclined by repletion; the solid aliments therefore do not seem to leave the stomach, before they have changed their fibrous or other texture for that of a mucous, as it were cineritious, yellowish, somewhat fetid, mucilaginous, and liquid pulp. That which is first prepared and turned fluid, goes before the rest out of the stomach; first water; then milk, pot-herbs, bread; and last of all, flesh-meats, the harder, tougher, and longer skins or fibres of which pass unchanged: but such things as are hard, or too large to pass the polyrus, are retained in the stomach for a long time.

But a considerable portion of the drink is absorbed by the pendulous vessels of the stomach itself: so their contents take a shorter way into the blood, as plainly appears from repeated experiments.

The stomach being irritated by too great a quantity or acrimony of the food, or else by sickness, a repulsion of the bile, or other cause, does, by an antiperistaltic or reverted motion of its fibres, drive its contents upward through the open and relaxed œsophagus in the act of vomiting. Any part of the whole intestinal canal, from the pharynx to the rectum, may be constricted slowly by an antiperistaltic motion. The effect of vomiting is partly from the pressure of the abdominal muscles depressing the false ribs, and urging the contents of the abdomen against the diaphragm; which, at the same time, contracting itself to a plane downward, forces the stomach, as betwixt the sides of a press, to throw up its contents.

But the aliments driven in their natural course to the duodenum, meet there with the influent bile and pancreatic juice, which often flow back into into the stomach.

From the exhaling arteries of the intestines distils a thin watery liquor into their cavity, like the juice of the stomach, not acrid, but saltish. The quantity of this liquor may be computed from the large extent or sum of all the excretory orifices, and from the secretory artery, larger than that which we see any where in the body; add to this, the laxity of the parts perpetually kept warm and moist. The mucus arising from the pores or cells before-mentioned serves to lubricate and defend the internal surface of the villous membrane, and to guard the sensible nerves from strongly acrid or pungent particles. Hence we see, it is more abundant at the beginning of the larger intestines, because there the mass of aliment begins to be more feculent, acrid, and tenacious.

The mixture of this liquor with the pulp like mass of the aliment, together with the bile and pancreatic juice, is made by the motion of the surrounding muscles of the abdomen; but this force is quite small, and unfit for moving forward the aliments. For this purpose therefore serves especially the peristaltic motion, which is more particularly strong and evident in the small intestines. For any part of the intestine, irritated by flatus or any sharp or rough body, contracts itself, even after death, most violently in that part where the stimulus is applied, in order to free itself from the distending body, which it expels into

the next open part of the lax intestine; where, being received, it is again propelled forward, by exciting a like stimulus and contraction as before. This contracting motion of the intestines is made in various parts of the gut, either successively or at the same time, wherever the flatus or aliment excite a stimulus; and this without observing any certain order. So well fitted, however, are the intestines for this motion, that they emulate, and even exceed, the irritability of the heart, or at least are scarcely exceeded by it. When they are not irritated, they remain at rest. The air acts chiefly as a stimulus to the intestines, next to it is the aliment, and lastly the bile. This peristaltic motion is performed by a wonderful sort of alternate creeping and revolution of the intestines, which dissection easily demonstrates in living brute animals, aud unhappy cases of wounds in the abdomen and ruptures have manifested in the human species. And since here, among so many inflexions, the weight of the aliment is but of little force, it easily ascends or descends through the irritated intestine, which thus empties itself. Hence the antiperistaltic motion is intelligible, by which the pulp of the alimetnary mass is oftener or longer applied with a gentle force to the triture of the intestine, to the exhaling diluent liquor, and to the mouths of the absorbing vessels. But all the contents of the intestine are determined downward to the large intestines, because the stimulus begins above, from the left opening of the stomach; and so, by the succession of new stimulus, it descends, when there is no resistance made to it, into the lower part of the ileum, at its opening into the colon: here the loose part of this intestine readily receives what is pressed into it by the contraction from above, and as easily unloads itself into the large unactive cæcum; whence it is again repelled upward, and in part urged on by the pressure of the succeeding mass. Anatomists observe, that this motion is made stronger downward than upward, and that the superior parts of the intestines are more irritable than the lower. But as often as an insuperable obstacle resists the passage of the aliment, there will be the seat of the principal contraction, and the aliment likewise is driven upward from the valve of the colon

through the whole length of the intestines, into the stomach, and lastly into the mouth.

This peristaltic motion of the intestines is performed by the constriction of their circular fibres, which know how to empty the tube exactly, without injuring the intestine against pins, or any other sharp bodies lodged within their contents, which they tenderly promote forward. But the revolutions of the intestines, drawn upward and downward, and the straightening of crooked parts of them one before another, which is so remarkably conspicuous in brute animals, are performed by the long fibres, which we see also contract themselves at the seat of the present stimulus, and dilate the following portion of them to receive what ensues. By the same contraction the villous membrane of the intestines, within their cavity, is urged and reduced into longer folds; whence the mucus is expressed and applied to that part of the alimentary mass, where it was required by the force of irritation and stimulus. These long fibres frequently make intro-susceptions of the intestines, and generally without any bad consequences, by drawing up the contracted portion of the intestine into that which is loose, in such a manner, that the former is surrounded by the latter, which is relaxed.

The alimentary pulp, therefore, diluted with the pancreatic juice and that of the intestines, intimately mixed with the saponaceous bile and circumjacent mucus, is more perfectly dissolved than by the efficacy of the stomach, in proportion as the sides of the intestines come into a larger contact, and approach nearer together; to which add the longer series of peristaltic motion, and the greater quantity of dissolving juices. In this manner the alimentary pulp, intermixed with air, forms a froth, without any kind of fermentation, which air is the same with what we commonly eructate from the stomach; but yet, at the same time, the acid or acescent force is subdued, while the oily or fat parts, dissolved by the bile, intermix with the watery juices, and give the chyle its usual milky appearance, like an emulsion, of a bright colour in the duodenum, at the first entrance of the biliary duct; from whence downward it closely adheres to the villous coat of the small intestines. But the gela-

tinous juices of flesh meats, diluted with a large portion of water, and likewise from their own, subviscid nature, do more particularly adhere to the villous coat, and enter it in the way of absorption. So water and watery liquors are all very greedily drank up by the absorbents; and yet the feculent remains never grow thick in the small intestines, as far as Haller has been able to observe, because the watery part is repaired by the arterial vapour and mucus; nor do they become fetid in any considerable degree, as well because of the great quantity of diluting juices, as because the quick progression will not allow them time enough for a putrefaction. Those remains, which are of a more earthy, gross, and acrid disposion, which were excluded by the mouths of the absorbing lacteal orifices, do, by their weight, or by the muscular contractions, descend slowly into the large intestines, so as to complete their whole course in the space of about twenty-four hours. But within three, four, or a few more hours time, all the chyle of the aliment is commonly extracted.

The considerable length of the small intestine, which is five or more times longer than that of the body, the great surface of the villous membrane increased by folds, the incredible number of absorbing vessels, the slow course of what remains through the large intestines, and the great quantity of the intestinal juice poured into the alimentary mass, do all of them concur in the small intestine, abundantly to perform what is required in the emulsions of the food for our healthy juices, and for their absorption into the lacteals.

The intestinal feces, retained in the blind beginning of the colon or large intestine, there grow dry by the absorption of moist vapours, so as to be capable of receiving a figure from the round contracted parts of the colon; they ascend from the bottom of the cæcum elevated by the long ligaments, which end in the worm-like appendix. And here the manner in which the feces are propelled by the contraction of the circular fibres, appears better than in the small ones. The longitudinal fibres of the intestine, being attached to the contracted parts as fixed points, draw up and dilate the lower parts of the intestine; then

the next parts of the intestine, to which the feces are brought, being irritated and contracted in like manner, are immediately after drawn together by the round and long fibres; by a successive repetition of which the feces finish their course entirely, through the whole large intestine for the most part in twenty-four hours in a healthy person.

While the gross feces ascend by the folds or valves of the ileum, the weight of them depresses the lower fold to the left side, which draws back the ligament common to each valve, in such a manner as to compress and exactly close the upper fold downward, that nothing may return back into the ileum; which might easily happen in a fluid state of the feces, if this valve was not so accurately shut up. The feces, when in danger of falling down from the upper parts, depress the upper valve, and thus accurately exclude themselves. This happens very exactly with the feces, but not so accurately with water. From thence they continue to move slowly forward, more dry, consistent, and figured by the same causes through the whole tract and repeated flexures of the colon, which is sometimes of five or seven feet in length, so as to retain the feces a space of time sufficient to give no interruption to the affairs of human life; and this time is proportionably less than twenty-four hours, the greater the velocity with which the small intestines propel their contents.

At length the figured excrement falls into the *rectum*, which is inflected first a little downward and then forward, of a broad depressed figure, at first descending contiguous to, and afterward spread under, the bladder or vagina, but connected more with the former than the latter. Here, for a great while, and often to a great quantity, the feces are collected together, in a part which is loose, or openly surrounded with soft viscera and muscles, with a good deal of fat.

The structure of the rectum differs very much from that of the other intestines. The external membrane or peritonæum is only spread before it; while behind it is supported by a broad stratum of the cellular substance, replenished with fat, and many conglobate glandules, connecting this intestine all the way to the os sacrum. The muscular fibres in this intestine are

much stronger and more numerous, more especially the longitudinal ones, than in the other intestines; being composed of the three ligaments of the colon, expanded and separated first over the anterior face, and then over the whole intestine; which they dilate against the advancing feces, and draw back the intestine after it has excluded them. But the transverse fibres are also strong; and the last of them are oval, forming a protuberant ring, which is the internal *sphincter* itself, by which the opening of the anus is closed.

Moreover, the villous tunic, extremely full of pores, and of a rough surface, full of reticulated polygonous and tender wrinkles, has likewise some sinuses peculiar to itself. Namely, that part of the intestine which is next to the skin or outward opening, forms a white firm circle like a valve, into which descend the longitudinal folds, but incurvated and approaching one to another in the circle itself. Betwixt those folds are intercepted sinuses, hollow upward, and of a greater depth towards the lower extremity of the intestine. Into the cavity of these open the mouths of the large mucous glandules; while the margin of the anus itself is defended by sebaceous glandules, that it might not be excoriated by the harder acrid feces.

Upon the exclusion of the feces, the constriction of the sphincters, and the action of the other muscles is not perpetual but voluntary; though the anus seems to close itself naturally, if the smallness of its opening be compared with the largeness of the intestine above, and with the corresponding wrinkle, aided by the strength of the transverse fibres of the internal sphincter and of the incumbent bladder.

Therefore, whenever the feces are collected to some quantity within the rectum, so as to be troublesome by their weight, irritation, or acrimony, they excite an uneasiness through the adjacent viscera; and are then urged downward by a voluntary pressure through the straits of collapsed intestine by the force of the incumbent diaphragm exciting an effort; which urging downward with great force, the viscera of the abdomen, which is always full, are determined downward through the inner rim of the pelvis, so as to urge upon the contents of the less resisting

bladder and rectum. When the resistance of the anus is thus overcome, the compressing forces of the diaphragm abate, and the feces continue to discharge from the body, urged only by the peristaltic motion itself of the intestine. After the feces are expelled, the intestine is drawn back or up into the body by its longitudinal fibres; after which the opening of the anus itself is closely contracted by the two proper sphincters as at first. These feces in men and carnivorous animals are very fœtid, almost putrid, subalkaline, soft, and contain much oil intimately mixed with salts, which are left both by the aliments, as well as by the bile and other humours of the human body. An acrid and fœtid water returns from the feces into the blood; hence costiveness in fevers is hurtful, putrefaction being increased by the affusion of the above-mentioned matter into the body.

LIVER AND GALL BLADDER.

Situation, figure, and division, of the liver. The liver is a large and pretty solid mass, of a dark red colour, a little inclined to yellow, situated immediatey under the arch of the diaphragm, partly in the right hypochondrium, which it fills almost entirely, and partly in the epigastrium, between the appendix ensiformis and spina dorsi, and terminating commonly in the left hypochondrium, into which it sometimes runs a considerable way.

The figure of the liver is irregular, it being convex on the upper part, unequally concave on the lower, and very thick on the right and back sides. Toward the left and anterior sides, its thickness decreases very much, and terminates there by a kind of edge; and it is broader from right to left than from before backward.

The liver may be divided into two extremities, one great, the other small; two edges, one anterior, and one posterior; two sides, one superior and convex, which is smooth, polished, and proportioned to the arch of the diaphragm, and one inferior, concave and uneven, with several eminences and depressions; of which hereafter.

It may likewise be divided into two lateral parts, called *lobes*; one of which is termed the *great* or *right lobe*, the other the *small* or *left lobe*. These two lobes are distinguished above by a membranous ligament, and below, very plainly, by a considerable scissure, lying in the same direction with the superior ligament.

The eminences on the concave side of the liver belong to the great lobe. The principal eminence is a sort of triangular or pyramidal apophysis, situated backward near the great scissure which distinguishes the two lobes.

This triangular eminence is termed simply the *small lobe of the liver*, or *lobulus Spigelii*, though it was known to several anatomists long before his time. One of its angles advances a considerable way toward the middle of the lower side of the great lobe, and is lost there. This angle we call the *root* of the lobulus. Toward the foreside there is another eminence less prominent, but broader; and to this eminence, and the former, the ancients gave the general name of *portæ*.

The depressions on the concave or lower side of the liver, which deserve our attention, are four in number. The first is the scissure that separates the two lobes, which runs across the concave side, from the eminences already mentioned, to the anterior edge, where it terminates by a notch of different depths in different subjects. This is termed the *great scissure* of the liver; and in some subjects part of it is an entire tube. The second depression is situated transversely between the two eminences of the great lobe, and filled by the sinus of the *vena portæ*, so called by the ancients because it lies between the eminences of the same name. The third depression is backward between the great lobe and lobulus Spigelii, and the vena cava passes through it. The fourth is a kind of sulcus between the lobulus and small lobe of the liver, which in the fœtus served to receive a venal canal lost in adults, in whom it appears only as a kind of ligament. This sulcus is in some measure a continuation of the great scissure, and joins the vena cava by an acute angle.

Besides these four depressions, there is one on the forepart of

the great lobe, in which the vesicula fellis is lodged; and it sometimes runs as far as the edge, where it forms a small notch. We may likewise reckon among these depressions a small superficial cavity in the posterior and lateral part of the lower side of the great lobe, by which it rests on the right kidney; and likewise a superficial cavity in the left lobe, where it runs over the stomach.

Lastly, on the posterior edge of the liver, there is a great sinus common to both lobes, which gives passage to the spina dorsi and œsophagus, near the place where the vena cava descends; and we sometimes meet with scissures on both sides of the liver, which are not ordinary.

Ligaments of the liver. The convex side of the liver is commonly connected to the diaphragm by three ligaments, which are only continuations of the membranous lamina of the peritonæum. One lies near the edge of the extremity of each lobe, and one in the middle; and they are accordingly termed the *right*, *middle*, and *left ligaments.* There is a cellular substance, in the duplicature of each, in which the blood-vessels and lymphatics run, and which sends off a kind of lamina into the substance of the liver.

The right ligament sometimes connects the great lobe to the cartilages of the false ribs; and the left ligament, or that of the small lobe, is often double, and advances toward the middle ligament. This middle ligament begins below in the great scissure of the liver, near the eminences called *portæ;* and thence passes through the anterior notch, and over the convex side of the liver at the union of the two lobes, and is fixed obliquely in the diaphragm.

It is likewise fixed along the upper and inner part of the vagina of the right musculus rectus of the abdomen, in such an oblique manner as to be nearer the linea alba below than above.

Besides these ligaments, the great lobe of the liver is likewise connected to the right ala of the tendinous portion of the diaphragm, not by a ligament, but by a broad and immediate adhesion, without the intervention of the membrane of the peri-

tonæum, which is only folded quite round this adhesion, to form the external membrane of all the rest of the body of the liver.

This broad adhesion is commonly, though improperly, called the *coronary ligament:* but, in the first place, it is not a ligament, as has been already observed; and, secondly, it is not circular, but oval and very oblong.

It is not on the upper part of the convex side of the liver, but along the posterior part of the great lobe; the broad extremity of the adhesion lying nearer the notch, and the pointed extremity toward the right hypochondrium.

The middle ligament, called improperly the *suspensory ligament* of the liver, contains in its duplicature a thick white rope, like a round ligament, which was the umbilical vein in the fœtus. Thus the lower part represents a falx; the convex edge of which is shap, and the other rounded.

All these ligaments serve to keep the liver in its proper situation, and to hinder it from inclining too much toward either side: but we must not imagine that any of them serve to suspend it; because it is sufficiently supported by the stomach and intestines, especially when they are filled.

When the stomach is empty, or when we fast longer than ordinary, it is a common expression to say the stomach pinches us. As the liver is not then sustained by the stomach and intestines, it descends by its own weight, and, chiefly by means of the middle ligament, pulls the diaphragm along with it. It is in that place, therefore, that we have this uneasy sensation; and not at the superior orifice of the stomach, as is commonly believed.

The right or great lobe of the liver, which lies in the right hypochondrium, rests on the right kidney by a small superficia depression above-mentioned; and it likewise covers a portion of the arch of the colon and the pylorus. About two third parts of the small or left lobe lie in the middle of the epigastrium, and the remaining third part advances over the stomach toward the left hypochondrium.

This small lobe is situated almost horizontally; the great

lobe is very much inclined, and its thick extremity runs down almost in a perpendicular direction to the right kidney on which it lies, in the manner already said.

Structure of the liver. The liver is composed of several kinds of vessels; the ramifications of which are multiplied in an astonishing manner, and form, by the intertexture of their capillary extremities, an innumerable collection of small pulpy friable corpuscles, which are looked upon to be so many organs designed to separate from the mass of blood a particular fluid, termed the *bile.*

The greatest part of these vessels, from one end to the other, is included in a membranous vagina, called *capsula venæ portæ,* or *capsula Glissoni,* from an English author who first described it particularly, about the middle of the last century. This vagina is commonly considered as a continuation of the membrane which covers the liver, and which penetrates this substance along with the blood-vessels; but Sabatier is of opinion it is a continuation of the cellular membrane which covers the vena porta ventralis.

The vessel which carries the blood to the liver is called *vena portæ,* for the reason already given. The vena portæ may be considered as two large veins, the trunks of which are joined endwise, and send out branches and ramifications in opposite directions to each other; that one of these veins is ramified in the liver, the other lying without the liver, and sending its branches and ramifications to the viscera of the abdomen; and, lastly, that the first of these large veins may be termed *vena portæ hepatica,* the other *vena portæ ventralis.*

Vena portæ hepatica. The particular trunk of the vena portæ hepatica is situated transversely between the broad anterior eminence of the great lobe of the liver and the root of the lobulus in a particular scissure, and forms what is called the *sinus of the vena portæ.* From this sinus five principal branches go out, which are afterward divided into millions of ramifications through the whole substance of the liver.

At this place the vena portæ lays down the common office of a vein, and becomes a kind of artery as it enters, and is again ramified in the liver. The extremities of all these ramifications

of the trunk of the vena portæ hepatica end in the pulpy friable corpuscles of the liver.

Pori bilarii et ductus hepaticus. It is in these corpuscles that the bile is secreted; and it is immediately collected in the same number of extremities of another kind of vessels, which unite, by numerous ramifications, into one common trunk. These ramifications are termed *pori bilarii*, and the trunk *ductus hepaticus;* and the ramifications of these two kinds of vessels are invested together by the capsula of the vena portæ.

Hepatic veins. The blood deprived of this bilious fluid is reconveyed to the heart by a great number of venal ramifications, which afterwards unite into two or three principal branches, besides others that are less considerable, that terminate in the vena cava, and are all called by the name of *vena hepatica.*

The capillary extremities of the ramifications of the vena hepatica, join those of the vena portæ, and accompany them through the liver; and yet the great branches of both veins intersect each other in several places.

When we cut the liver in slices, it is easy to distinguish in each slice the ramifications of the vena hepatica from those of the vena portæ; the first being thinnest and largest, and adhering closest to the substance of the liver; whereas those of the vena portæ, which are invested by the cellular capsula, appear to be a little ruffled when empty; because the cellular capsula subsides when it is cut, but the other veins remain uniformly open, their sides adhering to the substance of the liver; besides, they are accompanied by branches of the hepatic artery and biliary ducts, which do not follow those of the venæ hepaticæ: and Sabatier observes, that the direction of the branches of the venæ hepaticæ is perpendicular to that of the vena portæ.

Hepatic artery. The liver receives from the arteria cæliaca a particular branch, termed *arteria hepatica;* which being very small when compared with the bulk of that viscus, seems designed only for the nourishment thereof, and not for the secretion of the bile. The ramifications of the artery are included in the cellular capsula, together with those of the vena portæ and pori bilarii.

The pulsation of this artery has been by some anatomists taken for that of the capsula, which they supposed to be muscular; and by this they have endeavoured to explain the arterial function of the vena portæ: but they have not considered, that the blood in this vein does not require to be pumped forward; because so swift a motion would have been prejudicial to the secretion of the fine oil of the bile, for which a slow and almost insensible motion is necessary. Cowper and Santorini were the first who doubted of the muscular nature of the capsula, and they have been followed in this by modern anatomists.

The liver is covered exteriorly by a particular membrane or coat, which is a continuation of the peritonæum. There is likewise a membranous or filamentary substance that runs through this whole viscus, and connects the ramifications and extremities of all its vessels to each other. This substance seems to be a complicated production of the capsula of the vena portæ, and of the external membrane of the liver.

The outer surface of this coat is very smooth, but its inner surface is uneven, being made up of a great number of thin membranous laminæ; between which we observe, very distinctly, numerous lymphatic vessels, on both the convex and concave sides of the liver.

We have already observed, that the substance of the liver is chiefly made up of an infinite number of pulpy friable corpuscles; each of which is bounded, and in a manner surrounded, by a particular expansion of the capsula Glissoni; and all these expansions are connected by common septa, in some measure resembling a bee-hive.

These corpuscles have several angles, especially in the inner surface of the liver; but near the surface they are raised in the form of small tubercles. Their pulpy texture appears like radiated villi, a small void space being left in the middle of each.

If we blow through a pipe into the vena portæ, vena cava, arteria hepatica, or trunk of the pori bilarii, but especially through the two veins, we observe the liver to swell, and the corpuscles near the surface are raised, and become more sensible. If we blow with much force, we burst these corpuscles;

and the air getting between them and the external membrane, raises it from the substance of the liver in blisters.

Ductus cholidochus. The ductus hepaticus, or trunk of the pori biliarii, having run a little way, joins another canal, called *ductus cysticus* or *vesicularis;* because it comes from the vesicula fellis, as we shall see in the description of that organ. These two united ducts form a common trunk, named *ductus cholidochus;* because it conveys the bile. This duct having reached the incurvation of the duodenum, insinuates itself through the coats of that intestine, and opens into the cavity thereof, not by a round papilla, but by an oblong orifice rounded at the upper part, and contracted at the lower like the spout of an ewer, or like a common tooth-picker.

The edges of this orifice are raised, broad, and plaited, as we may see by making this portion of the duodenum swim in clear water. At the entry of this orifice we see another small opening distinct from it, which is the orifice of the ductus pancreaticus; of which hereafter. Glisson was of opinion, that the extremity of the ductus cholidochus was furnished with a sphincter of muscular fibres, which was capable of shutting the orifice and of preventing the contents of the duodenum from entering it; but no such valve has been found by others, and the obliquity of the passage answers the same purpose.

Gall Bladder. The gall-bladder is a kind of small bag, shaped like a pear; that is, narrow at one end, and wide at the other. The wide extremity is termed the *fundus* or *bottom*, the narrow extremity the *neck*, and the middle portion the *body*. About one third of the body of the vesicula lies in a depression on the concave side of the liver, from the trunk or sinus of the vena portæ, where the neck is situated, to the anterior edge of the great lobe, a little toward the right side, where the bottom is placed; and in some subjects it advances beyond the edge, so as to oppose itself to the muscles of the abdomen under the edges of the false ribs.

Therefore when we stand, the vesicula fellis lies in a plane inclined a little from behind forward. When we lie upon the back, it is almost inverted. When we lie on the right side, the bottom is turned downward, and it is turned upward when

we lie on the left side; and these situations vary according to the different degrees of each posture.

The gall-bladder is composed of several coats; the outermost of which is a continuation of that which invests the liver, and consequently of the peritonæum.

The under side of the gall-bladder touches the colon at the beginning of the duodenum, and sometimes at the pylorus.

The second coat is said by some to be fleshy, and made up of two strata; one longitudinal, the other transverse, like that of the stomach or intestines; but excepting in robust subjects, there are scarcely any muscular fibres to be seen.

A whitish stratum is looked upon as the third coat of the gall-bladder, answering to the tunica nervosa of the intestines.

The innermost, or fourth coat, has on the inside a great number of reticular folds, filled with small lacunæ, like perforated papillæ, especially near the neck of the vesicula, where these folds are longitudinal, and afterwards form a kind of small pylorus, with plaits of the same nature with those in the great one. These lacunæ are looked upon to be glands. Sabatier admits only of the first and the last of these coats; and considers the intermediate substance as being merely cellular and vascular.

That side of the body of the vesicula which lies next the liver is connected to that viscus by a vast number of filaments, which run a great way into the substance of the liver. Among these fibres, in some animals, ducts have been observed a long time ago. They are most numerous near the neck of the vesicula; and they are named *ductus cysto-hepatici*, or *hepatico-cystici*: but no such ducts can be demonstrated in the human body.

The neck of the vesicula is formed by the contraction of the small extremity; and this neck bending afterwards in a particular manner, produces a narrow canal, named *ductus cysticus*. This incurvation represents, in some measure, the head of a bird, of which the cystic duct, by the gradual diminution of its diameter, expresses the beak. This cannot be seen when the liver is *extra situm*; and even *in situ* it is but very imperfectly seen, when, in order to view the concave side, the liver is raised and thrust too much against the diaphragm; for by thus inverting the liver, the curvature is disordered, and we see two in the place of one.

To see this curvature in its true natural situation, the liver is to be raised but very little, and the duodenum left untouched; then we must stoop and look under the liver, without disordering any thing. This incurvation is of use to hinder too precipitate a discharge of the bile contained in the vesicula, which some situations of the body might occasion.

The neck of the vesicula is nearly of the same structure with the other parts. It has on the inside several reticular rugæ and some folds, which appear like fragments of valvulæ conniventes, situated very near each other, from the neck to the contraction of the cystic duct. The first of these folds is pretty broad and large, and almost circular; the next is more oblique and smaller in size, and the rest diminish in the same manner. Taken all together, they form a kind of spiral flight, which may be seen through the neck on the outside, where it sometimes appears like a screw, especially when the neck is filled with any fluid. This observation is owing to M. Heister.

By slitting the neck and duct, we see all these folds very distinctly, especially when we examine them in clear water. When they are viewed in any other manner, they easily deceive us, being mistaken for true valves, because of their transverse situation. They may, however, in some measure, supply the place of valves, by hindering the bile from running too fast into the duodenum, and the contents of the duodenum from entering this duct. The structure of the biliary ducts appears to be entirely membranous, covered externally with a thick cellular substance, and lined within by a kind of tunica villosa, which is pierced with numerous holes, that make it appear like a sieve. Through these a mucous humour flows to save the ducts from the impressions of the bile. And the internal surface of all these biliary ducts, that is, of the ductus hepaticus, cysticus, and cholidochus, being examined through a microscope in clear water, appears to be nearly of the same structure through their whole extent.

The cystic and hepatic ducts after the incurvation of the neck of the vesicula, run very near each other, and appear to be separated only by raising up the liver to view them. The same disorder happens in an inverted liver extra situm; for then the

body of the liver subsides and is flattened, and thereby separates the ducts ; whereas, in its true situation, it is very much incurvated, and the ducts very near each other.

The ductus cholidochus appears rather to be a continuation of the ductus cysticus than the common trunk of that and of the ductus hepaticus ; for this last duct runs for some space within the sides of the former, before it opens into the cavity ; much in the same manner as the ductus cholidochus passes into the duodenum. Winslow has observed, at the opening of the hepatic into the cystic duct, a small loose valvular membrane, which may hinder the bile from returning out of the ductus cholidochus into the hepaticus. But later anatomists describe only a sharp angle at the meeting of the cystic and hepatic ducts similar to the bifurcation of the arteries or veins.

The bile, which passes through the ductus hepaticus into the cholidochus, may be called *hepatic* ; and that which is collected in the vesicula fellis, may be termed *cystic*. The hepatic bile flows continually through the ductus cholidochus into the duodenum ; whereas the cystic bile flows only by reason of plenitude or by compression.

Remarks on the vessels, &c. of the liver. The trunk of the vena portæ ventralis terminates between the lobulus and the opposite part of the great lobe ; and there joins the trunk of the vena portæ hepatica in the transverse sinus of the liver, between the right extremity and the middle of that sinus.

The umbilical ligament, and consequently the umbilical vein in the fœtus, joins the trunk of the vena portæ hepatica toward the left extremity of the transverse sinus of the liver. The canalis venosus in man is not exactly opposite the vena umbilicalis, but a little to the right hand ; and therefore these three vessels lie in such a direction as to form two opposite angles, resembling those of the handle of a wheel or of a spit.

In the fœtus, therefore, the blood which comes from the umbilical vein does not run directly through that contained in the vena portæ hepatica in the sinus, and thence into the canalis venosus ; but is obliged to turn from left to right, and so to mix with the blood in the vena portæ, before it enters that

canal which opens into the trunk of one of the great hepatic veins of the vena cava near the diaphragm.

Below the hepatic veins, the vena cava inferior, in its passage by the liver, receives several other small hepatic veins, which seem to have the same relation to the hepatic artery as the great veins to the vena portæ.

The passage of the vena cava is through the right portion of the posterior sinus of the liver, and consequently on the side of the great lobe, which is hollowed at this place sufficiently to give passage to the vein, of which it surrounds about three-fourths, sometimes more, and sometimes the whole.

This passage answers to the interstice between the lobulus and the rest of the great lobe ; and its direction is, in the natural state, from below upward, and a little from left to right : but when the liver is viewed extra situm, and inverted, it appears very oblique ; but still it serves as a guide to beginners, who are very apt to be mistaken in examining an inverted liver.

The trunk of the great vena portæ, the hepatic arteries, the ductus hepaticus, or trunk of the pori bilarii, and the nerves of the plexus hepaticus, form all together a large bundle before they enter the liver. The trunk of the hepatic vena portæ is in the middle of this bundle ; the hepatic arteries lie on the right and left sides of this trunk, the nerves surround it on all sides, and they communicate with the plexus mesentericus superior.

Afterward the first branches of the arteries, nerves, and pori bilarii, leave the trunk of the great vein, and join in the same manner the trunk of the small or hepatic vena portæ, and its ramifications in the capsula Glissoni.

All these branches of the vena portæ, and of the arteries, nerves, and pori bilarii, accompany each other by ramifications through the whole substance of the liver, forming every where small fasciculi, in the same manner as the large bundles formed by their trunks. Each ramus of the vena portæ, artery, nerve, and porus biliarius, has a proper vagina, and all the four have a common vagina distinguished from the former cellular septa, which are only continuations of the vaginæ of both kinds.

The convex side of the common cellular vagina is connected quite round to the substance of the liver by numerous filaments

which arise from it, and which form the cellular substance found between the glandular corpuscles. The concave side produces the cellular septa above-mentioned.

In this common vagina, the vessels, ducts, and nerves, are disposed in such a manner, as that the rami of the vena portæ chiefly fill the cavity of it, and lie in a lateral situation: the arterial ramus and porus bilarius lie together on the side of the vein, and the nerve is divided into several filaments, which run in between the vessels and ducts, and chiefly accompany the artery and porus bilarious; the vena portæ having by much the fewest.

The uses of the liver shall be explained after the description of the pancreas, spleen, and omentum, all these viscera having a great relation to the liver.

PANCREAS.

Figure, division, and situation, of the pancreas. The pancreas is a long flat gland, of that kind which anatomists call *conglomerate*, situated under the stomach, between the liver and the spleen. Its figure resembles that of a dog's tongue; and it is divided into two sides, one superior, the other inferior; two edges, one anterior, the other posterior; and two extremities, one large, which represents the basis of a tongue, and one small and a little rounded like the point of a tongue.

The pancreas is situated transversely under the stomach, in the duplicature of the posterior portion of the mesocolon. The large extremity is connected to the first incurvation of the duodenum, and thence it passes before the rest of that intestine all the way to its last incurvation; so that a great part of the duodenum lies between the pancreas and the vertebræ of the back. The small extremity is fixed to the omentum near the spleen.

Structure of the pancreas. The pancreas is composed of a great number of soft glandular moleculæ, combined in such a manner, as to exhibit the appearance of one uniform mass on the outside, the surface of which is rendered uneven, only by numerous small convexities, more or less flatted. When these moleculæ are separated a little from each other, we find, along

the middle of the breadth of the pancreas, a particular duct, in which several smaller ducts terminate laterally, like small rami in a stem.

This canal, named *ductus pancreaticus* or *ductus Virsungi*, from the discoverer of it in the human body, is very thin, white, and almost transparent, and the extremity of the trunk opens commonly into the extremity of the ductus cholidochus. Thence it diminishes gradually, and terminates in a point, next the spleen. The small lateral branches are likewise pretty large near the trunk, and very small toward the edges of the pancreas, all of them lying in the same plane like the branches of the common filix or fern.

The pancreatic duct is sometimes double in man, one lying above the other. It is not always of an equal length, and sometimes runs in a winding course, but always in the same plane; and it is nearer the lower than the upper side of the pancreas. It pierces the coats of the duodenum, and opens into the ductus cholidochus, commonly a little above the prominent point of the orifice of that canal; and sometimes it opens immediately into the duodenum. SOEMMERRING has demonstrated its orifice to be somewhat valvular.

The small pancreas. In man, Winslow observed, that where the great extremity of the pancreas is connected to the curvature of the duodenum, it sends down an elongation, which adheres very closely to the following portion of the intestine; and, upon a careful examination, he found a particular pancreatic duct ramified like the large one, which ran toward and intersected this great duct, into the extremity of which it opened, after having perforated the duodenum. This portion he termed *pancreas minus*. It sometimes opens separately into the duodenum, in which we likewise observe several small holes round the ductus cholidochus, which answer to the pancreas.

The pancreatic duct is not only double in some subjects, as has been said, but the collateral branches have communications in several places, within the body of the pancreas.

The pancreatic juice, which is watery, insipid, and thin, is poured into the same place into which the bile discharges itself. The quantity of juice secreted by the pancreas is uncertain; but

it must be very considerable, if we compare the bulk or weight of it with that of the salival glands; than which it is three times larger, and seated in a warmer place. It is expelled by the force of the circulating blood, with an alternate pressure from the incumbent and surrounding viscera; as the liver, stomach, spleen, mesenteric and splenic arteries, with the aorta. The great usefulness of this gland may appear from its being found not only in man, but almost in all animals: nor is its use the less from that experiment which shows a great part of it may be cut out from a robust animal without occasioning death; because, in the experiment, a part of the pancreas must be left with the duodenum. Its effervescence with the bile arises from the effect of a ligature, and air mixed with the intestinal humour.

The pancreatic juice seems principally of use to dilute the viscid cystic juice, to mitigate its acrimony, and mix it with the food. Hence it is poured into a place remote from the cystic duct as often as there is no cystis. Like the rest of the intestinal humours, this juice dilutes the mass of aliments, resolves them, and does every other office of the saliva.

SPLEEN.

Situation, division, and figure of the spleen. The spleen is a bluish mass, something inclined to red, and of a long oval figure, being about seven or eight fingers breadth in length, and four or five in breadth. It is of a softish substance, and is situated in the left hypochondrium, between the great extremity of the stomach, and the neighbouring false ribs, under the edge of the diaphragm, and above the left kidney.

It may be naturally divided into sides, edges, and extremities. It has two sides, one external and gently convex, and one internal which is irregularly concave; two extremities, one posterior which is pretty large, and one anterior which is smaller and more depressed; two edges, one superior, and one inferior, on both which there are, in some subjects, several inequalities.

The inner or concave side is divided by a longitudinal groove or scissure, into two planes or half sides, one upper, the other lower; and, by this groove, the vessels and nerves enter in hu-

man subjects. The superior half side is broader and more concave than the inferior, being proportioned to the convexity of the great extremity of the stomach. The inferior half side lies backward on the left kidney, and forward on the colon; and sometimes this side of the spleen appears to have two superficial cavities, one answering to the convexity of the stomach, the other to that of the colon. The convex side of the spleen is turned to the left ribs.

It is connected to the stomach by the vessels called *vasa brevia;* to the extremity of the pancreas, by ramifications of the splenic artery and vein; and to the omentum, by ramifications which the same artery and vein send to the spleen, and which run in the longitudinal groove.

It is connected to the edge of the diaphragm by a particular membranous ligament of different breadths in different subjects, fixed in its convex side, sometimes near the upper edge, and sometimes near the lower. This ligament is situated transversely with respect to the whole body, and longitudinally with respect to the size of the spleen. In some subjects, it is connected by other ligaments to the stomach and colon; but in all this there are considerable varieties.

The figure of the spleen is not always regular, and is as various as the size. Sometimes it has considerable scissures both in the sides and edges, and sometimes it has appendices. Sometimes have been found a kind of small distinct spleens, more or less round, and connected separately to the omentum, at some distance from the anterior extremity of the ordinary spleen.

Structure of the spleen. The structure of the spleen is not easy to be unfolded in man; and it is very different from that of the spleens of brutes.

Its coverings adhere to it so closely in man, that it is difficult to distinguish the common from the proper coat; whereas in oxen, sheep, &c. nothing is more easy; for in such animals we find two coats separated by a cellular substance. This covering seems to be no otherwise a continuation of the peritonæum than by the intervention of the omentum and mesocolon; and even in man the two coats may be distinguished, where the vessels enter by the longitudinal scissure.

In man, the substance of the spleen is almost wholly vascular, that is, composed of the ramifications of all kinds of vessels. In oxen, the substance of the spleen is chiefly reticular, and in sheep it is cellular. In oxen and sheep, there are no venal ramifications; but instead thereof, only open sinuses, disposed like branches, except a small portion of a venal trunk perforated on all sides, at the extremity of the spleen.

Structure and use of the spleen. The spleen is one of those viscera which send their blood to the liver. The situation of it varies with that of the stomach itself, which it follows. When that is empty, the spleen is raised perpendicularly, so as to place its extremities right up and down: but when the stomach is full, the middle curve or arch of it arises upward and forward; and at the same time obliges the spleen to change its situation, so as to lie almost transversely with its lower end forward, and its upper end backward. Thus, being of a very soft and loose texture, it grows larger by distension when the stomach is empty, and becomes less again when its blood is pressed out by the distension of the full stomach against the ribs. Hence the spleen is found large in those who die of lingering diseases; but in those who die suddenly, and in full health of body, it is small. Another motion of the spleen is, that of descending with the diaphragm in inspiration, and ascending again in exspiration; and besides this, the spleen frequently varies in its situation with that of the colon. Frequently there is a second or less spleen placed upon the former.

The fabric of the spleen appears to be much more simple than has been commonly believed. For it is composed altogether of arteries and of veins; the former of which, after spending themselves in a great number of small branches, are at length thickly subdivided into very soft brushlike bunches, very difficult to fill with injection, terminating in circles; by which there is a ready passage for liquors into the corresponding veins. These circles, with their parallel branches, form a sort of bunches like a pencil brush, but of a shorter rounder kind; whence many have mistaken them for glands. Nor does the injection, rightly managed, ever escape from the vessels into the intervals; nor were any hollow glandules ever discovered by certain observation. Every

little arterial trunk, with the smaller twigs that proceed from it, are each of them surrounded by a very fine cellular substance or web-work, in the same manner with the small vessels of all the other viscera, but here rather softer. The whole body of the spleen is outwardly surrounded by a single membrane, which is not very tough, continued from the peritonæum, and joined to the fleshy part of the spleen by a pretty thick cellular texture.

Hence we observe, that the spleen contains more blood in proportion than the other viscera; since it has no muscles, fat, air-vessels, or excretory ducts, interposed betwixt its blood vessels. We learn also from observation, that the blood of this part hardly ever congeals, from the abundance of its volatile or bilious salts: but it looks of a dark-brown colour, and may be easily diluted; whence one may compare it almost to the blood of a fœtus.

The want of an excretory duct to the spleen, has occasioned the use of it to be doubtful, and controverted through all the ages of anatomy.

OMENTUM AND APPENDICES EPIPLOICÆ.

Situation, division, and connection of the omentum. The omentum is a large, thin, and fine membranous bag, surrounded on all sides by numerous portions of fat, which accompany and even invest the same number of arteries and veins adhering closely to each other.

The greatest part of it resembles a kind of flat purse; and is spread more or less on all the small intestines from the stomach to the lower part of the regio umbilicalis. Sometimes it goes down to the lower part of the hypogastrium, and sometimes does not reach beyond the regio-epigastrica. It is commonly plaited or folded in several places, especially between the bands of fat.

It is divided into a superior and inferior, an anterior and posterior, and a right and left portion. The superior portion is in a manner divided into two borders, one of which is fixed along the great curvature or convex side of the arch of the colon, and the other along the great curvature of the stomach. The commissure or union of these two borders on the right side, is fixed to the common ligament or adhesion of the duodenum and

colon, and to the contiguous parts of these two intestines. That on the left side is fixed to the longitudinal scissure of the spleen, to the extremity of the pancreas, and to the convex side of the great extremity of the stomach. It is likewise fixed to the membranous ligament which sustains the ductus cholidochus, and connects it to the vena portæ ventralis.

Below these adhesions, the other portions, that is, the anterior, posterior, two lateral and inferior portions, which last is the bottom of the sacculus epiploicus, have commonly no fixed connections, but lie loose between the foreside of the cavity of the abdomen and the intestines. The anterior and posterior portions are generally called the *laminæ* of the omentum.

Structure of the omentum. The membrane of the omentum is, through its whole extent, made up of two extremely thin laminæ joined by a cellular substance; the quantity of which is very considerable along the blood-vessels, which it every where accompanies in broad bands proportioned to the branches and ramification of these vessels. These cellular bands are more or less filled with fat, according to the corpulency of the subject.

Little omentum. Besides this large membranous bag, which is called the *great omentum*, there is another much smaller, which differs from the large one, not only in size, but also in figure, situation, and connection; and this is named the *little omentum.* This small bag is fixed by its whole circumference, partly to the small curvature of the stomach, and partly to the concave side of the liver before the sinus of the vena portæ, so as to surround and contain the prominent portion of the lobulus.

The little omentum is thinner and more transparent than the other, and its cavity diminishes gradually from the circumference to the bottom, which in some subjects terminates in several small cavities or fossulæ more or less pointed. Its structure is pretty much the same with that of the great omentum, it being composed of two laminæ, with a mixture of the same portions of fat, which are considerably finer than in the other.

We see from this situation of the two omenta, that in the space left between the lower side of the stomach and upper side of the mesocolon, they have a very broad communication with

each other; so that if either of them contained in its cavity any fluid, that fluid might readily get between the stomach and mesocolon, and so pass into the other bag; especially when the stomach is empty, and consequently its situation easily changed.

Therefore, by means of this interstice between the stomach and mesocolon, the two omenta form one cavity, which opens into the cavity of the abdomen by one common orifice, situated near the commissure on the right side of the great omentum. This orifice is semilunar or semicircular, and formed by the union of two membranous ligaments, whereof one connects the beginning of the duodenum and neck of the vesicula fellis to the liver; the other connects the contiguous portion of the colon to the same viscus, and extends to the pancreas. Thence arises an incurvated border, which surrounds the root of the lobulus, leaving an opening wide enough to admit the end of the finger.

The membranous laminæ of the little omentum are continuous partly with the external membrane of the liver, partly with that of the stomach, and a little with the membrane that lines the neighbouring portion of the diaphragm. Those of the great omentum are continued partly with the same coat of the stomach, and partly with the external covering of the colon, and consequently with the mesocolon; and they likewise communicate with the covering of the spleen.

Appendices epiploicæ. The fatty appendices of the colon and rectum are considered by Winslow as a kind of small omenta or appendices epiploicæ. They are situated at different distances along these intestines, being particular elongations of their common or external coat. They are of the same structure with the great omenta; and there is a cellular substance contained in their duplicature, more or less filled with fat, according as the subject is fat or lean.

Next the intestine, each of them forms a broad, thin basis; and they terminate by irregular papillæ, thicker than their bases. These bases are at first disposed longitudinally; then obliquely; and lastly, more or less transversely, especially near the rectum, and upon that intestine.

These appendices are for the most part separated from each other; but some of them which have longitudinal bases communicate together, the vestiges of these communications being very narrow, and not very prominent. By blowing through a small hole made in one of these appendices, it is inflated like a small irregular bladder, and the air passes under the external coat of the colon or rectum.

Besides these appendices epiploicæ, we observe at different distances along the colon, between the ligamentary band, which lies hid, and one of the other two, that is, on both sides of the adhesion of the mesocolon, several adipose strata, which may likewise be looked upon as appendices of the same nature with the former; but these strata are very seldom observed between the two apparent ligamentary bands of the colon.

SECRETION OF THE BILE.

The *liver*, being the largest of all the viscera, fills up a very large part of the abdomen in its upper chamber, above the mesocolon; and is still larger in proportion in the fœtus. It is surrounded on all sides by the neighbouring viscera, and fixed by ligaments in such a way that it is suspended in the body, with a considerable degree of firmness; yet so as to be allowed liberty to move and be variously agitated, raised and depressed, by the actions of the diaphragm.

This large viscus is as we have seen, proportionably supplied with vessels, and of various kinds. For, besides the arteries, it has the vena portarum, which receives all the blood of the stomach, of the intestines and mesentery, of the spleen, omentum, and lastly, of the pancreas, at first into two trunks; the transverse splenic and ascending mesenteric; then into one, which is continued with the mesenterics. This is large, composed of strong membranes, and surrounded with a good deal of cellular substance, derived to it from the mesentery and spleen, dense, short, and adding strength to the membranes; those with which it is furnished being harder than the aorta itself. Intermixed with this cellular substance, are also many of the smaller vessels and hepatic nerves, which all come together un-

der the denomination of a *capsula*. By this the vena portarum is conducted to the liver, and firmly sustained. But each branch of this vessel is divided into many others, again divided and subdivided, after the manner of arteries, till they at length produce the smallest capillaries. In this course every branch of the vena portarum is accompanied with a social branch of the hepatic artery, creeping upon the surface of the vein, and the contiguous hepatic ducts, almost in the same manner as the bronchial arteries usually creep along the ramifications of the windpipe in the lungs; while, in the mean time, both the artery and the vein are connected to the branches of the biliary ducts by a thin cellular substance. Some go out of the liver, being divided to the ligaments, and inosculating with the surrounding veins. And the sum of the branches in the vena portarum is always greater than the trunk; whence all the branches together greatly exceed that of the trunk.

But, since the blood is in this manner conveyed through the liver to the branches of the vena portarum, together with the hepatic artery, it must of course be conveyed back again by some other veins: and, therefore, the extreme branches of the vena portarum and hepatic artery inosculate ultimately into other veins, which are *branches of the cava*; which arising from the whole circumference of the liver, run together toward the posterior gibbous part of the liver into branches and trunks, which at last go off into ten or more large vessels. The lesser of these trunks, and greater number of them, pass out through the posterior lobule of the liver, and go to the cava through the sulcus, that lies on the right side of the lobule, often completed into a circle by a sort of bridge or production of the liver; whence they ascend together through the diaphragm toward the left side. Two or three trunks, much larger than the former, end into the same cava, close to the diaphragm, whose veins they often take in by the way. The branches of the vena cava are, in the adult, generally fewer and less than those of the vena portarum. As to any valves at the openings of these branches into the cava, there are none which deserve to be regarded. The trunk of the vena cava, passing through a foramen of the diaphragm, ob-

tusely quadrangular, surrounded and terminated by mere tendons, is thereby rendered not easily changeable: and having surmounted this opening of the diaphragm, it then immediately expands into the right auricle. The smaller veins of the liver creeping about its surface, are sent into the phrenics, renals, and azygos; or at least there is certainly a communication betwixt these and the hepatic veins coming from the portæ.

That the blood comes from all parts by the vena portarum to the portæ, is proved by a ligature, by which any vein betwixt these parts and the ligature swells; but the porta itself, above the ligature, grows flaccid and empty. But that it afterwards goes through the liver to the cava, appears by anatomical injections, which show open and free anastomoses or communications betwixt the vena portarum and the cava, together with the common nature of the veins going to the cava.

The interior fabric of the liver is more obscure. Through the whole substance of the liver go bundles of biliary vessels, of branches of the vena portarum, and of the hepatic artery. Each vessel has both its proper cellular texture surrounding it, and similar ligaments, by which it is tied to its fellow vessels; and, lastly, the whole bundle has its cellular texture placed round it. The branches of the vena cava lie on the outside of the rest, being less accurately received into the same bundle. Lastly, the ultimate small branches of the vena portarum, cava, and hepatic artery, together with the bilious ducts, are united together by means of the cellular substance, into a sort of mulberry-like bunches, of an hexagonal shape, surrounded with a lax cellular texture. In these bunches, likewise, there are mutual anastomoses betwixt the portal branches and hepatic artery, with the roots of the vena cava on one side, and the first organs of the pori biliarii of the liver on the other side; which last demonstrate their inosculations by anatomical injections; for liquors injected by the vena portarum return again through the porus cholidochus.

Haller is persuaded that no bile is separated from the hepatic artery; because the peculiar structure of the vena portarum would be useless if it secreted nothing. Its office in secretion appears plainly by the continuations of its branches with the

biliary ducts, in a manner more evident than that of the artery: but it appears by experiments, also, that the biliary secretion continues to be carried on after the hepatic artery is tied; add to this the largeness of the biliary ducts, in proportion to so small an artery, with the peculiar nature of the blood collected in the vena portarum, so extremely well fitted for the formation of the bile. But in the blood of the hepatic artery, says Haller, we can find nothing peculiarly fit for the secretion of bile, or analogous to its nature.

Since, therefore, the vena portarum conveys the blood ready charged with biliary matter, fit to be secreted in the least acini, and from thence there is an open free passage, without any intermediate follicles, from the ultimate branches of the vena portarum into the beginning roots of the biliary ducts, and that the humours driven into the vena portarum may easily choose this passage, the bile will be expelled thence by the force of the blood urging behind, as well as by the auxiliary force of the diaphragm pressing the liver against the rest of the viscera in the abdomen when very full; and again, contracted in expiration, it will be forced into the larger branches, and lastly into two trunks of the larger biliary duct of the liver; which trunks meet together in one upon the vena portarum, in the transverse fossa of the liver, near the anonymous lobule.

The fabric of this duct is made up like that of the intestines. But there is here no muscular fabric apparent. From experiments it appears to be endowed with a moderate degree of irritability. That it is vastly dilatable, is shown from diseases. The same seem also to show that this duct is endowed with a very sharp sensation.

The hepatic duct, thus formed, goes on upon the vena portarum, more to the right than the artery, towards the pancreas; and then descending obliquely, covered by some part of that gland, it goes to the lower part of the second flexure of the duodenum, and is inserted backward about four or five inches from the pylorus, through an oblique oblong sinus made by the pancreatic duct, into which it opens by a narrow orifice. The said sinus runs a great way through the second cellular coat of

the duodenum obliquely downward; then it perforates the nervous coat, and goes on again obliquely betwixt it and the villous tunic; and, lastly, it opens into a protuberant long wrinkle of the duodenum. Thus there is almost the length of an inch taken up betwixt the first insertion and the egress of this duct, through the coats of the duodenum, by a sinus which surrounds and receives the ductus cholidochus, in such a manner that when the coats of this intestine are distended by flatus, or closely contracted by a more violent peristaltic motion, the opening of the duct must be consequently compressed or shut; but when the duodenum is relaxed and moderately empty, the bile then has a free exit. Any regurgitation from the duodenum is hindered by this obliquity and wrinkling of the duct, easily pressed together, or joined by a quick succession of fresh bile descending perpendicularly from the liver. Nor does wind inflated into the intestine find any passage into the duct.

But, in the portæ themselves, this common duct receives another less canal of the same kind, which lies for a good way parallel with itself from the gall-bladder, making its insertion in a very acute angle; and this, which is called the cystic duct, from its origin, is sometimes first increased by another small duct from the hepatic before its common insertion. This duct is formed by the gall-bladder as a peculiar receptacle for the bile given to most animals; but is absent in some, especially those of a swifter foot, and perhaps only in such of these as are herbivorous: it is placed in an excavation of the right lobe of the liver, to the right side of the anonymous lobule, in such a manner, that in infants or children it lies wholly within the edge of the liver, but in adults projects considerably beyond, lying upon the intestinum colon. Its situation is almost transverse from the fore to the back parts; its neck ascends a little upward.

The figure of the gall-bladder is variable, but in general like that of a pear, terminated in its forepart by an obtuse hemispherical end, which is impervious, gradually diminishing backward; the neck or tip of this truncated cone being inflected upward against itself once or twice, and tied together by the cellular substance belonging to it, makes then another small flex-

ure upward, and begins the cystic duct; which thence goes on toward the left side of the hepatic duct. Within this duct there are many protuberant wrinkles, formed by the numerous cellular bridles which tie them together: and these wrinkles, conjunctly in the dry gall-bladder, represent a kind of spiral valve; but being altogether soft and alternate in a living person, they do not stop, only lessen the course of the bile, as we are assured from experiments, by pressing the gall-bladder, and by inflations. Besides, it is reticulated like the gall-bladder itself.

The coats of the gall-bladder are like those of the intestines, only the second coat has sometimes splendent fibres, chiefly longitudinal; but some obliquely intersecting each other in various directions; at other times it has none at all: so that we may doubt of its muscular nature, especially as the irritability of the gall-bladder is slow and obscure. The inner coat differs from that in the intestine, in being reticulated and full of cells.

The generality of animals, between their gall-bladder and liver, or between the ducts coming from both, have, besides, some peculiar openings in the gall-bladder, into which some ducts originating from the liver, or the hepatic biliary duct, discharge their contents. In mankind these ducts have not been shown by any certain experiment; and the gall-bladder is easily loosed from the liver, without a drop of bile distilling either from it or from the liver. There is also a thin water in the bladder as often as the cystic duct is obstructed.

The bile flows both out of the bladder and liver, according to its nature, as long as there is no impediment in its way; so that both ducts swell when that passage is obstructed, and the cystic lies in a straight line with the cholidochus. Nor is it credible that all the bile should be diverted into the gall-bladder before it flows into the duodenum. There is not a perpetual obstacle which hinders the afflux, and peculiarly resists the hepatic bile, and admits the cystic; the passage into the ductus cholidochus is larger and straighter, the ductus cysticus much less than the hepatic, nor is that duct so well formed for receiving all the

bile; the cholidochus being much larger than the cystic duct, cannot therefore be made only for the reception of its bile. There are many animals in which the hepatic duct discharges its contents into the intestine without any communication with the cystic. In living animals, even when the cystic duct is free, the bile appears to descend into the duodenum with a perpetual current. That the quantity is very considerable, appears from the magnitude of the secretory organ, and the excretory duct, so many times larger than the salival ones; from diseases, in which four ounces of the cystic bile only have flowed out duly through an ulcer of the side. But the hepatic bile goes into the bladder, as often as there is any obstruction in the duodenal sinus, from flatus or any other cause compressing the exit of the ductus cholidochus. Accordingly, we find it extremely full, whenever the common biliary duct is obstructed or compressed by some scirrhous tumor, whence the gall-bladder is sometimes enlarged beyond all belief; and if the cystic duct be tied, it swells betwixt the ligature and hepatic duct; and in living animals, the hepatic bile visibly distils into the wounded gall-bladder, even to the naked eye. The retrograde angle, or direction of this duct, is not repugnant to such a course of the bile: for a very slight pressure urges it from the liver into the gall-bladder; and even wind may be easily drove the same way, more especially if the duodenum be first inflated. Nor does there seem to be any sort of bile separated by the gall-bladder itself. Whenever the cystic duct is obstructed by a small stone, or a ligature made upon it, we find nothing separated into the gall-bladder more than the exhaling moisture, and a small quantity of insipid mucus secreted from the follicles. In many animals, we meet with no appearance of any gall-bladder, when at the same time there is a plentiful flux of strong well prepared and salutary bile discharged into their intestines. Again, it does not seem probable, that the cystic branch of the vena portarum can separate bile into the gall-bladder; for that vein in itself is a mere reconductory vessel: nor can any be separated from the hepatic artery: for it must be vastly beyond probability, that such a strong bile as that of the gall-bladder should be

separated from a milder blood than the more soft hepatic bile prepared from the blood which is most fit for that purpose.

Lastly, the bile flows also from the gall-bladder to the liver, and at length returns into the blood when its passage into the intestines is totally intercepted.

Therefore a portion of the hepatic bile being received into the gall-bladder, there stagnates, only a little shaken by respiration; and there, by degrees, exhales its thinner parts, which, as we see, filtrate through and largely penetrate the adjacent membranes. The remainder, as being a fluid of an oily subalkaline nature, digesting in a warm place, grows sharp, rancid, more thick, bitter, and of a higher colour: for this is all the difference betwixt the cystic and hepatic bile; which last we find weaker, less bitter, lighter-coloured, and of a thinner consistence, while it remains within its proper hepatic ducts. That this difference betwixt them proceeds only from stagnation, appears from such animals as have only a larger porus hepaticus, instead of a gall-bladder; for here we find the bile, which stagnates in the larger hepatic pore, is considerably more bitter than that in the smaller pores of the liver; as for example, in the elephant. But the gall-bladder gives this particular advantage, that it receives the bile when the stomach, being empty, has no call for it, that afterward it may be able to return it in greater plenty, when we principally want it for the digestion of the aliments now flowing in great quantity into the duodenum. This flow of the bile is quicker in proportion through the cystic duct, as the section of that duct is less than the section of the gall-bladder.

The gall-bladder, indeed, hardly touches the stomach, but the beginning of the descending duodenum. But when the stomach is extremely distended, and in a very full abdomen, it makes a considerable pressure both upon the liver and duodenum; by which the gall-bladder is urged, and its bile expressed. Thus the bile flows through a free passage from the gall-bladder into the common duct and the duodenum: and this it does more easily in persons lying on their back; in which posture the gall-bladder is inverted, with its bottom upward. Hence it is that

the gall-bladder becomes so full and turgid after fasting. The expulsive force of the bile is but little more than that of the pressure received from the stomach and diaphragm; for as to any muscular force residing in the fibres of the proper membrane, which may be thought to contract the gall-bladder, it must be very weak and inconsiderable.

The hepatic bile is always bitter, but the cystic is more so; always viscid; of a full yellow colour, with a tincture of green; miscible, by triture, either with water, oil, or vinous spirits; coagulable by mineral acid liquors; dissoluble by alkalies, especially the volatile kinds; and extremely well adapted to dissolve oily, resinous, or gummy substances; quickly putrifying, and by putrefaction spontaneously degenerating to a musk-like odour. Its chemical analysis, and experiments of mixture with various substances, demonstrate, that it contains a large portion of water, and a considerable quantity of inflammable oil, which, in stones of a gall-bladder, appears very evidently. The bile, therefore, is a natural soap; but of that sort which is made from a volatile saline lixivium, mixed with oil; and has its water along with it. This, therefore, being intermixed with the aliment, reduced to a pulp, and slowly expressed from the stomach by the peristaltic force of the duodenum and pressure of the abdominal muscles, incorporates them all together; and the acid or acescent qualities of the food are in some measure thus subdued, the curd of milk is again dissolved by it into a liquid, and the whole mass of aliment inclined more to a putrid alkalescent disposition: it dissolves the oily matters, so that they may freely incorporate with the watery parts, and make up an uniform mass of chyle to enter the lacteals; the surrounding mucous matter in the intestines is hereby absterged and attenuated, and their peristaltic motion is excited by its acrimony; all which offices are confirmed, by observing the contrary effects from a want or defect of the bile. Nor is the hepatic bile sufficient to excite the necessary motion of the intestines, if the cystic is wanting; both which are of so much use and importance to the animal, that we find, by experiment, even the strongest will perish in a few days, if the flux of bile to the intestines be intercepted, by wounding the gall-bladder.

Thus it slowly descends along with the alimentary mass ; and having spent its force, or changed its bitterness by putrefaction, most of it is afterward excluded together with the feces ; but probably some of the more subtle, watery, and less bitter parts, are again taken up by the absorbents. It returns the less into the stomach, because of the ascent of the duodenum, which goes under the stomach, with the resistance it meets with from the valvula pylori, and the advancement of the new chyle which the stomach adds to the former : in man, however, it frequently enters ; and always in birds. The bile is of a sweet soft nature in the fœtus ; for in them the blood seems not sufficiently charged for its secretion to supply putrid alkaline vapours to the liver, nor are there any oily or fat substances absorbed from the intestines. As the bile is a viscid fluid, and thickens by inactivity of body in fat animals, and in us from the same causes, especially when the blood moves languid from grief ; so it easily coagulates into an hard, somewhat resinous, and often stony substance, insomuch that stones of the gall are much more frequent than those of the urinary bladder, as we are taught by experiments. Its use is manifest, as, being triturated with the aliments, it dissolves oil, resists acidity, and thus stimulates the intestines to contraction.

The use of the liver, besides secreting the bile, is manifest in the fœtus. It seems to transmit the blood brought back from the placenta, and to break its force. Even in an adult person it has the same use though less manifest, namely to retard the return of the blood coming back from the chylopoietic viscera.

SECTION II.

ANGIOLOGY.

DIVISION I.

OF THE ABSORBENT SYSTEM.

FOR the discovery of the principal parts of this system, we are chiefly indebted to Asellius, Pecquet, Rudbeck, Jolyffe, and Bartholine. Some of the vessels of which it consists had been indeed seen and mentioned by their predecessors, but it was in too cursory a manner to give them any title to the discovery. Thus the lacteals had been seen in kids by Erasistratus, who calls them *arteries*, as we are informed by Galen: and the thoracic duct had been seen by Eustachius, who speaks of it as a vein of a particular kind.

In 1622, Asellius discovered those vessels on the mesentery, which, from their carrying a milk-like fluid, he denominated *lacteals*. This discovery being made by opening a living dog, anatomists were thence encouraged to make experiments on living animals; and Pecquet, on opening a dog in the year 1651, found a white fluid mixed with the blood in the right auricle of the heart. Suspecting this fluid to be chyle, he endeavoured to determine how it got from the lacteals into the heart: this he found was by means of the ductus thoracicus, which he traced from the lacteals to the subclavian vein; and thus he clearly proved the existence of that duct which we now consider as the trunk of the system. Just before this time the lacteals had been supposed to terminate in the liver; conformably to the idea which the physiologists of that period had adopted about the use of this organ, which, from the authority of the older anatomists, they believed was the viscus hæmatopoeticum, or received the chyle from the intestines to convert it into blood.

In the years 1651 and 1652, Rudbeck, Jolyffe, and Bartholin, discovered the other parts of this system, which, from their carrying a transparent and colourless fluid, are called the *lymphatic vessels.* Thus there was proved to exist in an animal body a system of small vessels containing fluids very different from the blood, and opening into the sanguiferous vessels at the left subclavian vein.

After this period, Nuck added to our knowledge of this system, by his injections of the lymphatic glands; Ruysch, by his description of the valves of the lymphatic vessels; and Dr. Meckel, by his accurate account of the whole system, and by tracing those vessels in many parts where they had not before been described.

Besides these authors, Doctors Hunter and Monro have called the attention of the public to this part of anatomy, in their controversy concerning the discovery of the office of the lymphatics.

When the lymphatic vessels were first seen and traced into the thoracic duct, it was natural for anatomists to suspect, that as the lacteals absorbed from the cavity of the intestines, the lymphatics, which are similar in figure and structure, might possibly do the same office with respect to other parts of the body: and accordingly, Dr. Glisson, who wrote in 1654, supposes these vessels arose from cavities, and that their use was to absorb; and Frederic Hoffman has very explicitly laid down the doctrine of the lymphatic vessels being a system of absorbents. But anatomists in general have been of a contrary opinion; for from experiments, particularly such as were made by injections, they have been persuaded, that the lymphatic vessels did not arise from cavities, and did not absorb, but were merely continuations from small arteries. The doctrine, therefore, that the lymphatics like the lacteals, were absorbents, as had been suggested by Glisson and by Hoffman, has been revived by Dr. Hunter and Dr. Monro, who have controverted the experiments of their predecessors in anatomy, and have endeavoured to prove that the lymphatic vessels are not continued from arteries, but are absorbents.

To this doctrine, however, several objections were started, particularly by Haller; and it was found, that before the doctrine of the lymphatics being a system of absorbents could be established, it was first to be determined, whether this system existed in other animals, besides man and quadrupeds. Mr. Hewson claims the merit of having proved the affirmative of this question, by discovering the lymphatic system in birds, fish, and amphibious animals. The celebrated SOEMMERRING has observed that these vessels are more than proportionably larger in tall men, and, more than proportionably less in men of inferior stature.

OF THE ABSORBENT SYSTEM IN GENERAL.

The absorbent system consists of the lacteals, the lymphatic vessels, their common trunk, the thoracic duct, and the glands called *conglobate.*

The lacteals begin from the intestinal tube, and can for the most part be seen in a dog or other large quadruped that is killed two or three hours after eating, when they appear filled with a white chyle: but they do not always convey a fluid of this colour; for, even in a dog, if opened long after a meal, they are found distended with a liquor that is transparent and colourless like the lymph; and in birds the chyle is never found white, but always transparent: these vessels, therefore, might, with as much propriety, be called the *lymphatics of the intestines.*

The lymphatic vessels are small pellucid tubes that have now been discovered in most parts of the human body: the fluid they contain is generally as colourless as water; a circumstance which procured them at first the name of *ductus aquosi,* and afterward that of *vasa lymphatica.* The course of the lymph, like that of the chyle, is from the extreme parts of the body towards the centre, and many of the lymphatic vessels lie close to the large blood-vessels. If therefore a ligature be thrown round the large blood-vessels of the extremities of a living animal, or of one just dead, that ligature, by embracing the lymphatics, will stop the course of the lymph, which by distending the vessels will make them visible below the ligature.

All the lacteals, and most of the lymphatic vessels, open into the thoracic duct, which lies upon the spine, and runs up toward the neck of the animal, where it commonly opens into the angle between the internal jugular and subclavian veins of the left side; and thus both the chyle and lymph are mixed with the blood. If therefore a ligature be thrown round the thoracic duct immediately after killing an animal, not only the lacteal, but also the lymphatic vessels, in the abdomen and lower extremities, become distended with their natural fluids.

The lacteals, the lymphatics, and the thoracic duct, all agree in having their coats thinner and more pellucid than those of the blood-vessels. But although their coats are so thin, they are very strong, as we daily see on injecting them with mercury, since they resist a column of that fluid, whose weight would make it burst through blood-vessels, the coats of which are many times thicker than those of the lymphatic sytem.

The thinness of the coats prevents our dividing them from one another, and thereby ascertaining their number as we do those of the blood-vessels. But as the blood-vessels have a dense internal coat to prevent transudation, we have reason to believe the lymphatics have the same. And as the blood-vessels have a muscular coat, which assists in the circulation; so may the lymphatics. This is rendered probable from what Dr. Haller says of his having found them irritable in his experiments, and also from what is observed on seeing them in living animals distended with their lymph, in which case they appear of a considerable size; but upon emptying them of their contents, they contract so much as not to be easily distinguished. This experiment, Mr. Hewson informs us, he frequently made in the trunk of the lacteals in a goose, and on the lymphatic vessels on its neck; both of which, when distended with their natural fluids, are as large as a crow-quill; but, upon emptying them in the living animal, he has seen them contract so much that it was with the greatest difficulty he could distinguish them from the fibres.

The coats of lymphatic vessels have, in common with all other parts of the body, arteries, and veins, for their nourishment. This is rendered probable by their being susceptible of

inflammation; for they are frequently found in the form of a cord, painful to the touch, and extending from an ulcer to the next lymphatic gland. These painful swellings of lymphatic vessels likewise show that their coats have sensibility, and therefore that they have nerves as well as arteries and veins. Besides, we can clearly trace in different parts of the body blood-vessels running along their surfaces.

The lymphatic system in most animals, but particularly in man and quadrupeds, is full of valves. These valves have been painted by the celebrated Nuck, Ruysch, and others, and are much more frequent than in the common veins, and thence these lymphatics have sometimes been distinguished by the name of *valvular lymphatic vessels.* Those valves are generally two in number, are of a semilunar shape, and the one is sometimes much larger than the other. In most parts of the body these valves are so numerous, that there are three or four pair in an inch of space, but sometimes there is no more than one pair, sometimes several inches of a lymphatic appear without a valve. They are less numerous in the thoracic duct than in the branches of the system; thence it might be supposed, that in proportion as we go from the trunk to the branches, we should find them thicker set: but this is not always true, for Mr. Hewson observed them more numerous in the lymphatic vessels of the thigh than on those of the leg. When the vessels are distended with lymph, they appear larger on that side of the valves next the heart; which sometimes gives a lymphatic vessel an appearance of being made of a chain of vesicles: as such they are represented by some authors; but it is an appearance that very seldom occurs in the human body. In quadrupeds, however, this appearance is very remarkable. Wherever a lymphatic vessel enters the thoracic duct, we find either one or two valves which prevent the return of the lymph.

Lastly, the lymphatic system, in different parts of its course, has the glands called *conglobate* or *lymphatic.* These glands are so placed, that the vessels come in on one side, and pass out on the other, in their way to the thoracic duct. They are commonly of an oval, though sometimes of a round shape, and frequently somewhat flattened, and of various sizes; some being

no larger than a millet seed, while others are almost an inch in diameter. They vary in colour in different parts of the body, at different times of life. In young people they are generally of a reddish or brown colour; but become paler with age: they have a shining external surface, which is owing to a smooth dense coat that covers them. Like other glands, they have arteries, veins, and nerves, which enter into their composition: but with respect to the rest of their structure, anatomists are much divided in opinion. SOEMMERRING has endeavoured to prove that they are partly cellular and partly vascular. That these glands are wanting in some animals, is now generally known.

A PARTICULAR DESCRIPTION OF THE ABSORBENT SYSTEM IN THE HUMAN BODY.

THE absorbent system, beside the glands, is divided into three parts, viz. the lacteals, the lymphatic vessels, and the thoracic duct. The lacteals belong to the intestinal tube; the lymphatics, to all the other parts of the body; and the thoracic duct is the common trunk which receives both the lacteals and the lymphatics. We shall give a particular description of these, chiefly from Hewson, Mascagni, and Cruikshank, by whose attention this part of anatomy has been so greatly illustrated.

LYMPHATIC VESSELS OF THE LOWER EXTREMITIES.

These may be divided into two sets, viz. a superficial, and a deep-seated.

The superficial set of lymphatics consists of numerous vessels that lie between the skin and the muscles, and belong to the surface of the body or the skin, and to the cellular membrane which lies immediately under it. Of these there are numerous large branches that can be readily enough discovered in the limbs of dropsical subjects. Many of these run upon the top of the foot; and others are generally to be found just under the inner ancle.

The greater number of superficial lymphatics accompany the vena saphena major. They can be first traced from the toes; and there they run somewhat like the arteries and veins. A plexus, consisting of several vessels, runs over the top of the foot with the saphena to the inner ancle; and thence upward to the inner side of the knee. Here they are joined by another set which arises from the sole, and passes up on the inner and back part of the leg. A third set arises from the outer side of the foot, and runs by the outer ancle. Upon the outer part of the leg, these split into two divisions; one of which crosses obliquely over the forepart of the leg to the lymphatics, at the inner side of the knee, while the remaining part accompanies the vena saphena minor, and runs to the glandulæ popliteæ. From the inside of the knee a plexus runs up, consisting of from a dozen to twenty trunks, which pass afterward on the anterior and inner side of the thigh to the inguinal glands. In their passage they receive branches from the outer and back parts of the thigh; but these are few in number when compared with the rest.

The lymphatic glands of the groin are six, seven, eight, or upward; they vary much in number: of these, some lie in the very angle between the thigh and the abdomen, and others lie a few inches down on the forepart of the thigh. The lymphatic vessels, above described, enter the lowermost of these glands. One or more of these branches, however, frequently avoids the glands, and afterward bends over to another; from which go vessels to the other lymphatic glands that lie in the angle between the thigh and the abdomen, and sometimes a few enter no glands till they reach those on the inside of Poupart's ligament.

Into the inguinal glands also numerous lymphatics pass from the superficial parts of the abdomen and pelvis.

It is in these upper glands alone that the lymphatic vessels of the genitals enter.

In the penis three principal vessels commonly take their origin from the prepuce. These soon unite, and afterward separate upon the middle of the dorsum penis into two parts; one of which goes to the inguinal glands on the right side, the other to

those on the left, and which are situated at the upper and anterior part of the groin.

The deep seated lymphatics arise from the glans and body of the penis, and accompany the arteries into the lower part of the pelvis. Hence if venereal matter be absorbed by these vessels, the constitution may be affected without our being aware of it.

The lymphatic vessels of the testicle are numerous and very large for the size of this organ. They arise from its coats, from the body of the testicle, and from the epididymis; and after running along the spermatic cord, terminate in the lumbar glans. In their course they have few communications with each other.

The lymphatics of the scrotum, which are also numerous, go chiefly to the glands of the groin, though some pass along with those of the testicle to the lumbar glands.

The lymphatic vessels of the penis and scrotum having joined those of the thigh, a network is formed, which enters the abdomen under the edge of the tendon of the external oblique muscle, called *Poupart's ligament*. This plexus on the inside of Poupart's ligament consists of many branches; some of which embrace the iliac artery, but the greatest number of them pass up on the inside of the artery.

The superficial lymphatics of the inferior extremity are the trunks of those vessels which absorb from the skin and the cellular membrane immediately under it; but they likewise communicate with the deep seated absorbents: and the same thing is to be observed with respect to the lymphatics on all the other parts of the surface of the body.

Upon these vessels, from the foot to the groin, there is commonly not one lymphatic gland, besides those of the ham. But this rule has likewise some exceptions: for, even at the lower part of the leg, there are sometimes very small ones, and it may be concluded, that the lymphatic glands, even in the human body, are in number and situation a little different in different subjects.

Besides these superficial lymphatic vessels which lie above all the muscles, or in the cellular membrane under the skin, there is a set deeper seated that lie amongst the muscles, and accom-

pany the arteries, and like the veins, one lies on each side. Of these the principal trunks can be discovered by cutting down to the posterior tibial artery, near the inner ancle. By introducing pipes into these parts, they may be injected.

From the inner ancle, these vessels pass up along with the posterior tibial artery, being hid amongst the muscles on the back part of the tibia. About the middle of the leg they sometimes, though rarely, enter a small gland, which has been supposed to exist more frequently than it really does. Afterward they are seen in the back part of the ham, still lying close to the artery, and in the ham they pass through two or three glands which are commonly found there. But after they have passed these glands, they commonly divide into two or three branches, which accompany the crural artery, and pass with it through the perforation in the triceps muscle. Besides these, similar, though smaller, lymphatics accompany the anterior tibial and the fibular artery; these run likewise to the glands of the ham. The lymphatic vessels having perforated the triceps, pass up with the artery, and sometimes enter a gland, which is deeper seated than those which appear in the groin: from this gland they pass into the superficial glands, where the lymph of the deep seated and of the superficial lymphatics is mixed, and is conveyed into the body. At this part likewise the lymph from the penis and scrotum is mixed with that brought by the two sets of lymphatics from the lower extremities; and the whole enters the abdomen, under Poupart's ligament.

ABSORBENT VESSELS OF THE TRUNK.

The lymphatics of the lower extremities having now reached the trunk of the body, and having passed under Poupart's ligament, appear upon the sides of the ossa pubis near the pelvis. A part of them passes up along with the iliac artery upon the brim of the pelvis; and another part dips down into the cavity of the pelvis, and joins the internal iliac artery near the sciatic notch. At this place they are joined by the lymphatics from the contents of the pelvis, particularly from the bladder and the vesiculæ seminales in the male, and from the uterus in the fe-

male; and there are likewise several branches which pass through the sciatic notch from the neighbourhood of the glutei muscles. The lymphatic vessels of the uterus, like its blood-vessels, are much enlarged, and therefore easily distinguished, in the pregnant state of that organ. They are in two sets; one runs along with the hypogastric arteries and veins; the other with the spermatic vessels. The lymphatics of the external parts of generation in the female go partly to the inguinal glands of each side, and partly through the rings of the external oblique muscles to terminate in the glands of the loins or pelvis. At this part, where so many lymphatic vessels join, there is commonly one or two glands.

Besides these lymphatic vessels which dip down into the cavity of the pelvis on the inside of the external iliac artery, there are others which keep on the outside of that artery upon the psoas muscle. Of these, one part passes up to the loins, and goes under the aorta in different branches, getting from the left side to the right, and joining the thoracic duct. Another part passes under the iliac arteries, and appears upon the os sacrum, making a beautiful network, joining the lymphatics of the right side, and passing under the iliac artery, to form the network upon the upper part of the right psoas muscle. In different parts of this course from Poupart's ligament to the loins, and also in the loins themselves, there are, in most subjects, many lymphatic glands.

The lymphatic vessels of the right side, joined by some from the left, having now reached the right lumbar region, appear there in the form of a plexus of large vessels, and pass through several glands. At this part likewise they receive large branches, under the aorta, from the plexus on the left side of the loins, as is mentioned before; and having at last got up as high as the second, or more frequently the third lumbar vertebra, they all join, and form a single trunk called the *thoracic duct*. At this part they are likewise joined by the *lacteals*, which shall be next described.

The LACTEAL VESSELS, so called from their commonly conveying a fluid that is of the colour of milk, are found in two sets which communicate with each other; the internal begin from

the inner surface of the intestines, where each lacteal is at first formed upon the surface of the villi by numerous small radiated branches, with orifices destined to imbibe the nutritious fluid or chyle: from the cavity of the intestines these vessels pass obliquely through their coats, uniting as they go, so as to form larger branches. They follow the course of the arteries and veins, and are double their number; one being situated on each side. These branches run on the outside of the gut to get to that part which is next the mesentery; and, whilst they are yet upon the gut, they are sometimes of a size sufficient to admit a small pipe, so that they have been frequently injected with mercury in the human subject. And in man as well as in different animals the external set appear between the peritonæal and muscular coat, and commonly run for a considerable way in the same direction with the intestine.

From the intestines they run along the mesentery and mesocolon, toward the spine; passing through the lacteals in their way to the conglobate or mesenteric glands. These glands divide the lacteals into two regions: from the intestines to the glands these vessels are called *lactea primi generis;* and from the glands to the thoracic duct, *lactea secundi generis.*

The lacteals of the *jejunum* are larger and more numerous than those of the *ilium.* Those of the small intestines, as they run upon the mesentery, commonly accompany the superior mesenteric artery, and unite as they proceed into larger branches; so that by the time they arrive at the root of the mesentery, they are of a considerable size. From the mesenteric artery they descend by the sides of the aorta, and open at last into the thoracic duct: the lacteals, or rather the lymphatics of the large intestines, run somewhat differently. Those from the cæcum, and from the right part and great arch of the colon, join the trunk of the lacteals of the small intestines about the root of the mesentery, whilst those from the rest of the colon terminate in the lumbar glands, or lower part of the thoracic duct, accompany the inferior mesenteric artery, and communicate with the large lymphatic vessels near its root.

Into the thoracic duct, likewise enters the lymph of the other abdominal viscera. This is brought by a number of vessels,

which in all the viscera run in a superficial and deep set; a plexus of these may be traced from each kidney, lying principally behind the emulgent artery, and opening into a large lymphatic vessels near the aorta. The lymphatics of the kidney are seldom seen in the sound state of that viscus; but when it is enlarged or ulcerated, they are sometimes observed distinctly: they run from its outer toward its inner edge, and immediately afterward pass through the glands of the loins. The lymphatics of the glandulæ renales, or renal capsulæ, likewise terminate in the renal plexus.

The lymphatic vessels of the spleen pass from the concave side of that viscus, along with the splenic artery in the sinuosity of the pancreas, by the lymphatic vessels of which they are joined. The deep seated lymphatics of the spleen are very considerable, and can be readily seen at its concave edge, but those on its surface are small and few in number in quadrupeds; however, as in the bullock, they are remarkably numerous and large.

To the stomach belong two sets of lymphatic vessels, the one running upon its lesser, and the other upon its greater curvature. Of these, the former accompanies the coronary artery, and passes through some lymphatic glands that that lie by its sides. The other set passes from the great curvature of the stomach, partly to the left and partly to the right side. Those on the left side receive the lymphatics of the left half of the great omentum, and run with the lymphatics of the spleen and pancreas to the thoracic duct. Those on the right side, receive the lymphatics from the right half of the great omentum, and pass through some lymphatic glands that lie close to the arteria gastrica dextra. Descending by the pylorus, they meet the plexus that accompanied the coronary artery; and near the lesser curvature of the duodenum, from a considerable network. Into this not only the lymphatics form the spleen enter, but likewise those from the gall-bladder, together with the deep-seated lymphatics of the liver. Several branches proceed from this network; some running under the duodenum, and others over it; which all open into the throacic duct, near the termination of the large trunk of the lacteals. The thoracic duct therefore is the

common trunk that receives the absorbent vessels of the lower extremities, the lacteals, and the lymphatics of the abdominal viscera.

The lymphatics of the liver, like those of the other viscera, are in two sets; one which lies upon the surface of the organ, and the other which accompanies the large blood-vessels in its centre. Here these two sets are found to communicate with each other very freely; so that, by injecting mercury into the lymphatic vessels which lie upon its convex surface, we may fill those which accompany the pori bilarii and vena portarum in its centre. Most of the lymphatic vessels which lie upon the convex surface of the liver, run toward its falciform ligament, and pass through the diaphragm into glands which are situated on the anterior part of the pericardium. But others of them run toward the lateral ligaments of the liver, where they pass also through the diaphragm, and afterward run on its upper surface to join those from the ligamentum latum. This is the common course of the absorbents on the convex side of the liver; but there is great variety.

From the glands above-mentioned, a large trunk runs up behind the sternum, between the laminæ of the anterior mediastinum, and commonly joins the thoracic duct near its termination. Sometimes, however, instead of finding one trunk behind the sternum, we meet with two or more in each side of the thorax accompanying the internal mammary-vessels: those of the left side ending in the thoracic duct; those in the right going into the lymphatic trunk in that side of the neck.

The lymphatics on the concave surface run toward the portæ, where they join those which come from the centre of the liver along with its large blood vessels. After they get from the liver, they are found to be very numerous. They pass into glands on the vena portarum; and afterward end in the thoracic duct, near the root of the superior mesenteric artery. It is remarkable of those lymphatic vessels which run upon the surface of the liver, that their valves can readily be made to give way, so that they may be injected from their trunks to their branches, with great minuteness.

It has been suggested by Dr. Meckel, that the lymphatics of the stomach do not open into the thoracic duct like those of the other viscera, but only open into the sanguiferous veins of the stomach: but from repeated dissections of the human subject, Mr. Hewson has been convinced of the contrary; and likewise from the analogy with other animals, particularly fish, whose lymphatic vessels either have no valves, or the valves readily give way, so that he has repeatedly pushed injections from the thoracic duct into the lymphatics of their stomachs, as he has also done into the lymphatics of the other viscera contained in the cavity of their abdomen.

The thoracic duct, which receives all the vessels that we have yet described, differs in its size in different subjects, but is always smaller in its middle than at its beginning. Sometimes its lower part is very large; and that enlargement has been called the *receptaculum chyli*, and is considerable in some quadrupeds, in turtle, and in fish: but many anatomists have denied that there is any part of the thoracic duct in the human subject that deserves the name of *receptaculum*, having never seen any thing like a pyriform bag, as it has been described, but merely an enlargement not unlike a varix, and that only in few subjects. This lower extremity of the thoracic duct is formed by the union of two or three very large trunks of lymphatic vessels. The first, second, and other parts already described, are formed by the lymphatics of the inferior extremities; the third belongs chiefly to the lacteals. These large vessels unite so as to form the duct over the third vertebra lumborum, reckoning from above downward. Upon the second vertebra of the loins, the union of these vessels is sometimes twice or thrice as large in diameter as the duct is higher up; at other times little or no enlargement can be observed.

These large lymphatic trunks which form the thoracic duct are spread out upon the spine, those of the right side lying below the right crus diaphragmatis, and those of the left passing between the aorta and the spine; whilst the thoracic duct itself lies at first behind the aorta; but afterwards passes from that upward, and a little to the right side, till it gets before the first vertebra of the loins. Here it is situated behind the right crus

of the diaphragm, where it enlarges again; and sometimes forms a pyriform bag, which has been considered by authors as the beginning of the duct. From this part it passes upward, being at first covered by the crus diaphragmatis, and afterwards appears in the thorax, upon the spine between the aorta and the vena azygos. In the thorax it receives some lymphatics from the intercostal spaces; and afterward it receives vessels from the lungs.

The superficial lymphatics of the lungs form a beautiful net-work, the larger branches running chiefly between the lobules, the smaller passing over them; and here, as well as on the liver, and other parts, there are numerous valves; the existence of which has by some been denied. From the surface they pass to the root of the lungs, and there they go through the bronchial glands. At this place they are joined by the deep-seated absorbents which creep along the branches of the trachea, and likewise on those of the pulmonary artery and vein. Having left the glands, the principal part of those from the left lung form a trunk which terminates in the thoracic duct behind the division of the trachea into its right and left branches. The rest of the absorbents of the left lobe pass through glands behind the arch of the aorta, and which are likewise common to those of the heart. They run at last into the thoracic duct near its termination in the red veins.

After leaving the bronchial glands, the absorbents of the right lung form three or four principal trunks; one of which commonly ascends on the forepart of the vena cava superior, and opens into the lymphatic trunk, that terminates in the veins of the right side of the neck. The rest of these trunks go into the thoracic duct at the root of the lungs; and near this place the absorbents of the right and left lungs communicate pretty freely together.

At the root of the lungs, where the large blood-vessels enter, are many glands called *bronchial*. They are generally of a blackish colour in the human subject, and have been suspected to secrete the mucus which is spit up from the trachea; but later anatomists having frequently distinctly filled them with

mercury by injecting the lymphatic vessels of the lungs, think it evident that they are not mucous but lymphatic glands.

The absorbents of the heart, which have been known only by the latest anatomists, come from its superficial and deep parts. These afterwards form principal trunks which accompany the coronary arteries and veins, and like them the largest belong to the left ventricle. From the side of the right coronary artery an absorbent passes over the arch of the aorta to a gland commonly found behind the origin of the carotid arteries. The lymphatic accompanying the left coronary artery is formed of two principal branches; one of which runs up in the groove between the ventricles; and on the superior surface of the heart, the other runs in a correspondent groove on the under side of the heart: and having reached the space between the auricles and ventricles, turns round to join the former branch near the origin of its corresponding artery. Frequently a third branch comes in between the other two. The trunk runs next to a gland between the arch of the aorta and the under end of the trachea; and at this place, as was formerly mentioned, the glands are common to the absorbents both of the heart and lungs. The absorbent accompanying the right coronary artery passes into the trunk, which terminates in the right subclavian vein; while the other, accompanying the left artery, goes to the upper end of the thoracic duct.

The thoracic duct, after receiving the vessels before mentioned, passes behind the ascending aorta, and goes to the left side, terminating in the angle between the jugular and the subclavian vein. But, just before its termination, it generally goes higher up than the angle, and then bends down towards it. Sometimes, though rarely, there are two thoracic ducts instead of one. Sometimes the duct splits near the upper part of the thorax; and the two branches, after spreading out from one another, commonly unite again at their termination in the angle between the jugular and subclavian veins.

To the preceding account, it may not be improper to add the description given of the *lacteal sac and duct* by the celebrated Monro.

"The receptaculum chyli, or saccus lacteus, is a membranous somewhat pyriform bag, two-thirds of an inch long, one-third of an inch over in its largest part when collapsed; situated on the first vertebra of the loins to the right of the aorta, a little higher than the right emulgent artery, behind the right inferior muscle of the diaphragm: it is formed by the union of three tubes; one from under the aorta, the second from the interstice of the aorta and cava, the third from under the emulgents of the right side.

"The lacteal sac, becoming gradually smaller toward its upper part, is contracted into a slender membranous pipe, of about a line diameter, which is generally named the *thoracic duct*. This passes betwixt the muscular appendices or inferior muscles of the diaphragm, on the right of, and somewhat behind the aorta: then, being lodged in the cellular substance behind the pleura, it mounts between the aorta and the vena azygos as far as the fifth vertebra of the thorax, where it is hid by the azygos, as this vein rises forward to join the descending or superior cava; after which the duct passes obliquely over to the left side behind the œsophagus, aorta descendens, and the great curvature of the aorta, until it reaches the left carotid artery; behind which, on the left side of the œsophagus, it runs to the interstice of the first and second vertebræ of the thorax, where it begins to separate from the carotid, stretching further toward the left internal jugular vein by a circular turn, whose convex part is uppermost. At the top of this arch it splits into two for a line and an half; the superior branch receiving into it a large lymphatic vessel from the cervical glands. This lymphatic appears, by blowing air and injecting liquors into it, to have few valves. When the two branches are again united, the duct continues its course toward the internal jugular vein, behind which it descends, and, immediately at the left side of the insertion of this vein, enters the superior posterior part of the left subclavian vein, whose internal membrane duplicated, forms a semilunar valve that is convex externally, and covers two-thirds of the orifice of the duct; immediately below this orifice, a cervical vein from the musculi scaleni enters the subclavian.

"The coats of the sac and duct are thin transparent mem-

branes; from the inside of which, in the duct, small semilunar valves are produced, most commonly in pairs; which are so situated as to allow the passage of liquors upward, but oppose their return in an opposite course. The number of these is generally ten or twelve.

"This is the most simple and common course, situation, and structure of the receptaculum chyli and thoracic duct; but having had occasion to observe a variety in these parts, of different subjects, I shall set down the most remarkable of them.

"The sac is sometimes situated lower down than in the former description; is not always of the same dimensions; is not composed of the same number of ducts; and frequently appears to consist of several small cells or ducts, instead of being one simple cavity.

"The diameter of the duct is various in most bodies, and is seldom uniform in the same subject; but frequently sudden enlargements or sacculi of it are observable.——The divisions which authors mention of this duct are very uncertain. I have seen it divided into two, whereof one branch climbed over the forepart of the aorta at the eighth vertebra of the thorax, and at the fifth slipped behind that artery, to join the other branch which continued in the ordinary course.—The precise vertebra, where it begins to turn to the left side, is also uncertain.—Frequently it does not split at its superior arch; in which case a large sac is found near its aperture into the subclavian vein.——Generally it has but one orifice; though I have seen two in one body, and three in another: nay, sometimes it divides into two, under the curvature of the great artery; one goes to the right, another to the left subclavian vein; and I have found this duct discharging itself entirely into the right subclavian.—The lymphatic vessel which enters its superior arch, is often sent from the thyroid gland.

"Whether is not the situation of the receptaculum chyli so much nearer the muscular appendices of the diaphragm in men than in brutes, designed to supply the disadvantageous course the chyle must otherwise have in our erect posture?

"Does not the descent of the end of the duct to the subclavian

vein, and the opening of the lymphatic into the top of the arch, contribute to the ready admission of the chyle into that vein?"

In the description of the lymphatic vessels which lie near the trunk of the body, only a few glands have been mentioned. For the lymphatic glands not being constant either in number or situation, the describing them particularly in any one subject appeared less necessary, since we cannot be sure of finding them exactly the same in any other. It may, however, be necessary to mention where they are commonly seen.

The mesentery of the human subject is well known to contain a considerable number of them, from 100 to 150 or upward; they are likewise found in the mesocolon, where the lymphatics of the large intestines pass through them; but here they are both smaller and less numerous than in the mesentery. The stomach has also several glands which belong to its lymphatic vessels, and lie near the arteria coronaria and the gastrica dextra. There are likewise a few upon the omentum in some subjects; and there are also many by the sides of the pancreas, particularly near the lesser lobe of that viscus, close to the duodenum.

Besides these glands which belong to the intestinal tube, there are many more in the cavity of the abdomen, and few in the cavity of the pelvis, which belong to the lymphatic vessels of the other organs.

There is commonly a pretty considerable gland seen just on the inside of the edge of the tendon of the external oblique muscle, called *Poupart's ligament*, on the outside of the iliac artery; and there are others near that artery, where it lies upon the psoas muscle. There are likewise commonly one or two near the internal iliac artery in the cavity of the pelvis; some on the surface of the os sacrum behind the rectum; and there is a considerable number generally met with by the sides, and upon the lumbar vertebræ.

Over the trunks of the blood-vessels of the spleen, liver, kidneys, and renal capsulæ, there are also lymphatic glands which belong to the lymphatic vessels of these organs. In the thorax, a few glands are found on the forepart of the pericardium and

upper surface of the diaphragm, and belong to the liver or diaphragm. Others are situated between the laminæ of the anterior mediastinum.

There are likewise lymphatic glands sometimes observed by the sides of the thoracic duct, particularly about the middle of the thorax; which glands belong principally to the vessels of the lungs.

There are many lymphatic glands (called *bronchial*) near the root of the lungs: these glands are placed upon the lymphatic vessels, just where they quit the lungs. But no lymphatic glands have yet been observed in the substance of the lungs; and the tubercles, which some suspected to be obstructed lymphatic glands, seem to have a different origin. There are likewise some glands seen on the lymphatic vessels which lie near the subclavian veins at the upper part of the thorax, and which belong to the lungs.

Besides these there are some lymphatic glands upon the aorta near the œsophagus, and there are also others occasionally met with in the intercostal spaces, and there are generally two or three contiguous to the thoracic duct at the lower part of the neck and upper part of the thorax near the termination of that duct in the angle between the left jugular and the left subclavian vein; and a few are found over the internal mammary vessels where the absorbents of the liver pass up within the thorax.

LYMPHATICS OF THE HEAD AND NECK.

The lymphatics of the head, like those in many other parts of the body, are in two sets; one belonging to the outer, the other to the inner, parts of the head. Those on the outside of the head accompany the blood-vessels, and pass through glands in their way to the neck. Those accompanying the temporal artery go through small glands at the root of the zygomatic process, while the absorbents of the occiput pass through others behind the mastoid process of the temporal bone.

Several anatomists have seen an appearance of lymphatics both on the brain and its membranes; but none even of the latest authors have been certain about these. That the brain, however, has its absorbents, there can be little doubt; as is in

some measure proved from the existence of lymphatics and glands, in or on the outside of the passages of the arteries and veins of the brain, from swellings in the lymphatic glands of the neck, arising from diseases of the brain, from the absorption of water which has sometimes happened in cases of hydrocephalus, and from several other circumstances.

From the superficial and deep parts of the head, the lymphatics pass through the glands situated near the carotid arteries and internal jugular veins, where they are joined by others, to be immediately described.

From the different parts of the face, the lymphatics chiefly accompany the branches and trunk of the facial artery. They come from the inner angle of the eye, from the nose, lips, and cheeks. Some of these pass through small glands on the outside of the buccinator muscle, while the principal branches go through larger glands on the outer and under side of the lower jaw, near the corresponding blood-vessels, and the inferior maxillary gland. Others run through the glands on the upper and under end of the parotid. The lymphatics of the inner side of the nose run principally with the internal maxillary artery, and pass through the glands behind the angle of the lower jaw, where they are joined by others from the inner part of the mouth. Deeper than this, and near the internal jugular vein, the lymphatics of the tongue, and parts about the os hyoides, pass through the glands which belong likewise to those of the deep parts of the head.

The lymphatics already described from the different parts which belong to the head, accompany the external and internal jugular veins, though chiefly the latter, where they form a large and beautiful plexus, passing through numerous glands in the whole length of the neck. At the under end of the neck they join the lymphatics of the superior extremities, and then form a common trunk to be afterward mentioned.

The glandula thyroidea has many lymphatic vessels, which can be inflated by blowing air into the cells of the gland: these vessels pass on each side of the treachea, one part going into the trunk, which terminates in the right subclavian and

jugular, and the other joining the thoracic duct upon the left side near its termination.

LYMPHATICS OF THE UPPER EXTREMITIES.

Like the leg, each arm has two sets of lymphatic vessels. One set, which lies immediately under the integuments, belongs to the skin and the cellular membrane, connecting it to the muscles; the other accompanies the large arteries, and belongs to the parts deeper seated.

The superficial set of lymphatic vessels are numerous, and may be discovered in emaciated dropsical subjects, by a careful dissection on the fore and back part of the arm. They arise first from the forepart of the fingers and palm of the hand, and run somewhat like the veins. They go to the fore arm, where they meet with others from the outer and inner edges of the hand. After running a little further, they receive many branches from the back part of the hand and fingers, and then form a plexus which surrounds the greater part of the fore-arm. Having got obove the elbow, most of them run near the basilic vein, and commonly pass through one or two small glands, a little above the internal condyle of the humerus, and over the brachial artery; but the lymphatics on that side of the arm next the thumb appear to pass through no glands till they reach the axilla. The rest of the lymphatics accompany the cephalic vein, and are but few in number: they pass between the deltoid and pectoral muscles, and then go through glands at the inside of the clavicle. Of the deep-seated lymphatics of the arm two commonly accompany each artery, in the same manner as the veins do: having reached the upper end of the arm, they go through the axillary glands, where they are joined partly by the lymphatics from the mamma and side of the thorax, and also by those from the shoulder. From these glands larger branches run under the clavicle, and form a trunk, which receives those from the head and neck already described.

These vessels, however, are only a part of the larger lymphatic vessels of the arm. They should moreover be considered

as only trunks of the lymphatics; since it is probable, that every (even the smallest) part of this, as well as all other parts of the body, has some of these vessels adapted to absorption. That this is the case, seems to be proved by the experiments made with the variolous matter; for at what part soever of the arm that matter is inserted, the lymphatic vessels take it up and carry it into the body, as can be traced by its inflaming the conglobate glands through which these vessels pass.

The thoracic duct is not only joined by the trunk of the lymphatics of the left arm, but also by the lymphatic vessels of the same side of the thyroid gland, and by the trunk of the lymphatics of the side of the head and neck, and also by some from the lungs of the same side.

The lymphatic vessels of the right side are commonly seen to terminate in the angle between the jugular vein and the subclavian. When seen to enter the subclavian vein at any other part, it appears to be only an accidental variety.

These lymphatic vessels of the right side form four considerable trunks, which join near their termination. These trunks are, 1. One from the upper extremity, lying above the clavicle between the subclavian artery and vein: this trunk is formed by the lymphatics, which come up with the brachial artery, and a plexus, which likewise belongs to the arm, and passes under the subclavian vein. 2. The trunk of the lymphatic vessels of the right side of the head and neck, which passes down on the outside of the jugular vein. 3. A lymphatic from the thyroid gland. 4. A trunk from the lungs of the right side: this trunk may be distinctly traced under the subclavian vein to its termination, in common with the others, at the union of the jugular and subclavian veins.

OF THE CHYLE.

THE chyle is a white juice extracted from the aliments, which is afterwards mixed with the blood. That its principal composition is of water and oil, seems evident, from the sweetness of its taste, from the whiteness of its colour, from its

acescent and coagulable nature, and from its lightness by which it swims on the blood; in all which properties it very much resembles an emulsion. It is composed of a vegetable farina, with animal lymph and oil. It every where retains the properties of the volatile and oily aliments. It changes into milk with very little alteration. But afterward it becomes more manifestly glutinous; since the pellucid serum it contains, either by exhaling the watery part, or by applying an intense heat, coagulates into a kind of jelly.

That the chyle is absorbed into the lacteal vessels, by the adhering villous coat, has been a long time known, by experiments of injecting tinctured liquors, which readily describe the same course; from the white liquor of the lacteals, let out from blood-vessels; and from the venous nature of them. But late experiments have taught us this in a much better manner. The chyle is absorbed by small openings in the extremity of each of the villi, by the same force which is common to all capillary tubes, and perhaps also by a living power in these tubes, by which it is taken up into the cavity of the absorbing duct at the time when the intestine is relaxed; but the parts, by which the absorbing duct begins in the intestine, being pressed by the succeeding constriction of the muscular fibres in the peristaltic motion, urges the contents further on into the duct, which begins to appear within the second cellular stratum. But there is a two-fold stratum of these absorbing vessels, one anterior, the other posterior, as we observed before of the blood-vessels. Thence, uniting into a larger canal in the first cellular stratum, the absorbed liquor enters into the lacteal vessel, which, in general, follows the course of the arteries, and likewise accompanies their arches, but conjoined with others similar to it into a very obliquely angled net-work. Very many arise from the first part of the small intestines under the mesocolon; some from the duodenum, and some from the large intestines themselves.

The lacteal vessels are furnished with valves in the very first cellular texture of the intestine, like those of the lymphatics, joined together by pairs, of a semilunar figure, which admit the

chyle passing from the intestines, but prevent its return, and sustain its weight. Through this whole course, the chyle is urged on by the peristaltic motion of the intestines, as well as by the contractile force of the vessels themselves, which, even after death, is strong enough to propel the chyle; to which add, the considerable pressure of the abdominal muscles, and other parts, determined by the valves.

But betwixt the plates of the mesentery, at the divisions of the vessels, are found an infinite number of small conglobate glandules. Some lacteal vessels are seen to pass these glands: most part enter them; and, being divided and subdivided through their cellular fabric, compose the greatest part of the gland. And, again, other lacteal vessels are produced out of every gland; and, being mutually joined among themselves, go off in little trunks, of which the ultimate and largest ones go out from the gland. In the same manner the chyle enters other glandules twice, thrice, or four times; nor does any lacteal vessel arrive at the thoracic duct without meeting some of these glandules, although it may pass by some without entering them. But that this is the true course of the chyle, by which it passes from the intestines to the mesenteric glands, appears from a ligature, by the vessel growing turgid betwixt the said ligature and the intestine; and from the nature of the valves themselves hindering any return back to the intestines.

What alteration the chyle undergoes within the cellular fabric of these glands is not yet sufficiently known; but it appears, in general, that some thin liquor distils from the arteries in this part, serving to dilute the chyle, into which it is poured. For it is observed, that after the chyle has surmounted all the glands, it appears more watery; and thin liquors, injected through the arteries, pass out into the cellular fabric of the glands, and mix with the chyle. Lastly, that a kind of cream appears manifestly in the glandules of infants.

From the last glandules, which are collected together in the centre of the mesentery, the lacteal vessels go out very large, and few, to the number of four, five, or more, which ascend together with the mesenteric artery; and intermix with the lymphatic plexus, that ascends from all the lower parts of the

body; creeps over the renal vein, and then goes along with that which takes its course behind the aorta from the lumbar glandules, and with the hepatics. Here the lymphatics take a variable course, but most frequently terminate in the receptacle of the chyle. In this the gelatinous lymph of the lower limbs, and of the abdominal viscera, mixes with the chyle, and dilutes its white colour ; thus sometimes it appears filled with a pellucid or reddish humour, but frequently also with a white milk. The receptacle of the chyle must suffer a considerable alternate pressure from the diaphragm and aorta, by which the chyle is moved faster through it, in proportion as the capacity of the receptacle is greater than that of the thoracic duct, into which it empties itself.

That the chyle comes from the intestines into this duct, is shown from injections, by which quicksilver may be driven from the first lacteal vessels to the thoracic duct ; from ligatures made on the duct itself, or the red veins which receive it, and by which the first and second lacteal vessels swell ; and from the manifest flux of the chyle into the thoracic duct, when the ligatures are removed.

It appears that the chyle flows throw the thoracic duct into the blood ; because, on tying the red veins, both the thoracic duct and lacteal vessels which are inserted into it swell up.

Haller has attributed the first cause of motion in the chyle, and of its absorption, especially to the attraction of the capillary vessels, which observe alternate pulses with the peristaltic contraction of the intestine. The attractile force fills the villosity ; the peristaltic force empties the villosity, and moves the chyle farther forward. The rest of its motions seem to depend on the strength of the membrane of the lacteal vessel itself, which, even after the death of the animal, expels the chyle, so that the vessels become pellucid, which before were milky. The alternate compressing force of the diaphragm also is of some efficacy in this case, and the motion of the chyle through the thorax is somewhat accelerated by the conduit itself ; which being pressed, moves the chyle so much the more quickly forward, as itself is larger than the thoracic duct.

The chyle mixed with the blood, does not immediately change its nature, as we learn from the milk which is afterward made of it; but after five or more hours have passed from the meals, almost to the twelfth hour, during all which space a woman will afford milk after it has circulated near 80,000 times through the body, fomented with heat, and mixed with a variety of animal juices, it is at length so changed that a part of it is deposited into the cellular substance, under the denomination of fat: a part of it is again configured into the red globules; another part, that is, of a mucous or gelatinous nature, changes into serum; and the watery parts go off, in some measure, by urine, in some measure exhaled by perspiraration; while a small part is retained in the habit to dilute the blood. Nor is it any thing uncommon for a pellucid lymphatic liquor to fill the lacteals, in a dying animal, instead of chyle; or for some of them to appear milky in one part of the mesentery, and limpid or pellucid in another; since, as to their fabric and use, they al o agree to answer the end of lymphatics. There are not, therefore, two kinds of vessels from the intestines; one to carry the chyle only, and another peculiarly for the conveyance of lymph. After the digestion has been completed some time, the lacteal vessels absorb pellucid watery juices from the intestines, whence they appear themselves diaphanous.

OF THE LYMPH.

AS the fluid contained in the lymphatic vessels resembles water in the circumstances of transparency and want of colour, their first discoveries denominated these vessels *ductus aquosi*, and seem to have concluded that the lymph was nothing but w ter.

From among those who adopted this opinion, should be excepted doctors Haller and Monro, who are of a different opinion. For if immediately after killing an animal in health, a lymphatic vessel be tied up properly, and then cut out of the body and opened, so as to let out the lymph into a cup and expose it to

the air, it will jelly as the coagulable lymph of the blood does in the same circumstances.

This fluid therefore approaches to the nature of coagulable lymph in this circumstance, but it differs from it in the time necessary for that coagulation. The time which the blood requires for its coagulation is about seven minutes after exposition to the air, but the lymph let out from the lymphatic vessels of the same animals, was found to require half an hour or more for its coagulation. And although the blood coagulates soonest in weak animals, yet the contents of the lymphatic vessels, do not, but seem later in jellying in proportion as the animal is reduced, or as they become more watery.

OF THE SUPPOSED ABSORPTION OF THE LYMPH BY THE RED VEINS.

This doctrine has been espoused by that excellent anatomist Dr. Meckel; to his observations, therefore, it may be necessary to pay particular attention.

Dr. Meckel's conclusions in favour of it, are made entirely from injections in dead bodies: for having filled the common veins by injecting mercury into the lymphatic glands, into the excretory ducts of the breasts, into the vesicula seminalis, into the hepatic ducts, and into the urinary bladder; he concludes, that the veins open into these parts in the living body to absorb from them. A conclusion which is already proved to be liable to considerable objections, as we never can be sure whether our injection, in getting from these cavities into such veins, had gone by a natural or by forced passage. Dr. Meckel does indeed mention, that there were no marks of an extravasation in his experiments. Perhaps it might have been too small for observation. Nay, we have even reason to believe, that as the small vessels of the human body are very close to one another, our injection may sometimes burst from one into another lying in contact with it, without distending the cellular membrane which lies between them. A circumstance which anatomists have sometimes observed, and which Mr. Hewson has seen happen

even on the mesentery of a turtle; where, upon injecting the lacteals, he has more than once made the mercury pass into the common veins: but in all these cases, on a careful examination, he found it was by rupture, as could readily be distinguished in this animal, whose mesentery is extremely thin and transparent. And that it was actually so, and not by a natural passage, must be evident to every anatomist who considers that this is an experiment which does not always succeed on the mesentery of the turtle, where, if there were natural passages, or if the lacteals opened into the veins, the mercury would probably run with great facility.

And the very same circumstance which Dr. Meckel has observed of a lymphatic gland, has happened to Mr. Hewson sometimes on injecting these glands in diseased cases; that is, he has filled the common veins, and in some instances where he looked for it, he could distinguish the extravasation very readily, and therefore concluded, that in the other cases where the veins were filled, that it was also an extravasation, though a more obscure one. From this he suspects, that in Dr. Meckel's experiment, where he filled the common veins, by injecting into the lymphatic vessels of a diseased gland, a similar deception had taken place; especially as the force applied was considerable, he having used a column of mercury eighteen inches high.

And the supposition of the red veins opening into a lymphatic gland, appears improbable from an observation concerning the structure of the glands, for which we are indebted to Dr. Meckel himself, viz. that they are made of a convoluted lympatic vessel. Now to suppose a lymphatic, which is a vessel given to absorb, should itself, even when convoluted, have a common vein opening into it for absorption from its cavity, does not appear consistent with what we know of nature's operations.

Similar objections might be made to the other experiments related by this very ingenious author; but enough has been said to show how cautious we should be in making conclusions, with respect to the passages of the living body, from experiments made on the dead, where, from the weakness of the vessels, and other circumstances, we are so liable to be deceived.

Upon the whole, on taking a review of the doctrine that the common veins are the instruments of absorption, that doctrine appears to have no other support than respect for the authority of our predecessors; for all the arguments in its favour are liable to considerable objections. Let us next, therefore, examine that part of the human body which in reality performs that important office.

OF ABSORPTION BY THE LYMPHATIC SYSTEM.

This system, in all animals, we have found, consists of a trunk or thoracic duct, and of two extremities, namely, the lacteals and the lymphatic vessels. The lacteals can be traced from the inner surface of the intestines, where they begin by small orifices, in order to absorb the chyle, and to transmit it through the thoracic duct to the blood-vessels. That this is their use, has never been questioned since the first discovery of those vessels, from its always admitting of easy demonstration; that is, by giving an animal milk, and then opening him a few hours after; in which case the same fluid that is seen in his intestines can likewise be seen to have got into his lacteals.

After thus being convinced, that the use of one branch of the system is to absorb, we cannot at first sight but wonder that any anatomist should have hesitated to attribute a similar office to the other.

The opinion of the lymphatics being a system of absorbents, was, after Glisson and Hoffman, adopted and supported with additional arguments by Dr. Hunter and Dr. Monro; who, besides showing the fallacy of the experiments brought in favour of the common veins doing the office of absorption, have advanced the following to prove that the lymphatics perform it.

First, their great analogy with the lacteals, with which they agree in their coats, in their valves, in their manner of ramifying, in their passage through the lymphatic or conglobate glands, and in their termination in the thoracic duct, and in short in every circumstance with regard to their structure; and thence it is probable they also agree with them in their use. And as the lacteals are known to begin from the surface of the

intestines, and to be the absorbents of these parts, the lymphatics may begin from the other cavities of the body, and may absorb the fluids which had lubricated those cavities.

Secondly, The passage of the venereal, variolous, and other poisons into the constitution; these poisons first making an ulcer, and then being absorbed along with the matter of the ulcer and infecting the whole body. That in such cases they are not absorbed by the common veins, but by the lymphatics, appears from their inflaming these lymphatics in their course, and by their generally inflaming a conglobate gland before they enter the system; a strong argument in favour of their being taken up by the lymphatic vessels, which pass through these glands in their way to the thoracic duct.

These two are the principal arguments by which the doctrine of the lymphatics being a system of absorbents has been supported.

SECTION II.

ANGIOLOGY.

DIVISION II.

OF THE HEART, LUNGS, AND ARTERIAL SYSTEM.

PREVIOUS to describing the arterial system of the human body, it will be necessary to give a general account of the THORAX and its contents.

By the thorax, we commonly understand all that part of the body which answers to the extent of the sternum, ribs and vertebræ of the back, both outwardly and inwardly.

The thorax is divided into the anterior part, called commonly the *breast;* the posterior part, called the *back;* and the lateral parts, called the *right* and *left sides.*

The internal parts of the thorax are contained in the large cavity of that portion of the trunk which is named the *cavity of the breast.* This cavity is lined by a membrane called *pleura,* which forms the mediastinum; and contains the heart and lungs, with the vessels, &c. which go into or out from them: through it likewise the œsophagus passes to the stomach, and part of the nerves are contained in it which go to the contents of the abdomen.

Cavity of the thorax. The hard parts which form the sides of this cavity, are, The twelve vertebræ of the back, all the ribs and the sternum. The soft parts which complete the sides, are, The membrane called *pleura,* which lines the cavity; and the musculi intercostales, sterno-costales, and diaphragma, already described.

All these hard and soft parts taken together, represent a kind of cage, in some measure of a conical figure, flatted on the foreside, depressed on the backside, and in a manner divided into two nooks by the figure of the vertebræ of the back, and terminated below by a broad arched basis inclined backward.

The intercostal muscles fill up the interstices betwixt the ribs, and so complete the sides of the cavity: the basis is the diaphragm; and the pleura not only covers the whole inner surface of the cavity, but, by forming the mediastinum, divides it into two, one on the right, the other on the left.

PLEURÆ AND MEDIASTINUM.

The pleura is a membrane which adheres very closely to the inner surface of the ribs, sternum, and musculi intercostales, sub-costales, and sterno-costales, and to the convex side of the diaphragm. It is of a very firm texture, and is supplied with blood vessels and nerves, in all which it resembles the peritonæum; and likewise in that it is made up of an inner true membranous lamina, and a cellular substance on the outside.

Each side of the thorax has its particular pleura, entirely distinct from the other, and making, as it were, two great bladders, situated laterally with respect to each other in the great cavity of the breast, in such a manner as to form a double septum or partition running between the vertebræ and the sternum, their other sides adhering to the ribs and diaphragm.

This particular duplicature of the two pleuræ is termed *mediastinum*. The two laminæ of which it it made up are closely united together near the sternum and vertebræ; but in the middle, and toward the lower part of the foreside, they are separated by the pericardium and heart, as we shall see hereafter. A little more backward they are parted in a tubular form by the œsophagus, to which they serve as a covering; and in the most posterior part, a triangular space is left between the vertebræ and the two pleuræ from above downward, which is filled chiefly by the aorta.

Before the heart, from the pericardium to the sternum, the two laminæ adhere very closely; and there the mediastinum is transparent, except for a small space near the upper part, where the thymus gland is situated: so that in this place there is naturally no interstice or particular cavity. The apparent separation is owing entirely to the common method of raising the sternum,

as was plainly demonstrated by Bartholinus, in his treatise of the Diaphragm, published at Paris in 1676.

The mediastinum does not commonly terminate along the middle of the inside of the sternum, as the common opinion has been. Winslow demonstrated in the year 1715, to the Royal Academy of Sciences, that from above downward it inclines towards the left side; and that if, before the thorax is opened, a sharp instrument be run through the middle of the sternum, there will be almost the breadth of a finger between the instrument and the mediastinum, provided that the sternum remain in its natural situation, and the cartilages of the ribs be cut at the distance of an inch from it on each side.

From all this we see, not only that the thorax is divided into two cavities entirely separated from each other by a middle septum without any communication; but also that, by the obliquity of this partition, the right cavity is greater than the left; but there are exceptions to the above descriptions. Lieutaud says he has met with several subjects in which the mediastinum descended along the middle of the sternum; and others, where it was inclined to the left side. Sabatier observes this is rare; but he has likewise met with several examples, where an instrument thrust through the middle of the sternum got into the left cavity of the thorax: and he has sometimes seen the right lamina of the mediastinum fixed to the middle of the sternum, while the left one was fixed opposite to the articulation with the cartilages of the ribs; a space being left between the two, which was filled with cellular substance, intermixed with fat.

The pleura is connected to the membranous portion of the sternum, ribs, and muscles; to the diaphragm, pericardium, thymus gland, and vessels; and, in a word, to whatever lies near its convex side.

The surface of the pleura turned to the cavities of the breast, is continually moistened by a lymphatic serosity which transudes through the pores of the membranous portion. This fluid is said to be secreted by imperceptible glands; but the existence of these glands has not been hitherto demonstrated.

Use. The pleura serves in general for an inner integument to the cavity of the thorax. The mediastinum cuts off all com-

munication between the two cavities, and hinders one lung from pressing on the other when we lie on one side. It likewise form receptacles for the heart, pericardium, œsophagus, &c. and it is continued over the lungs in the manner which shall be explained hereafter.

Before we leave the pleura, it must be observed that it adheres firmly to the ribs. This adhesion keeps the pleura stretched, and hinders it from slipping or giving way. It likewise renders this membrane extremely sensible of the least separation caused by a coagulated lymph or accumulated blood; the nervous filaments being likewise in this case very much compressed in inspiration by the swelling of the intercostal muscles.

THYMUS GLAND.

The thymus is an oblong very soft glandular body, round on the upper part, and divided below into two or three great lobes; of which that toward the left hand is the longest. In the fœtus it is of a pretty large size; less in children, and very little in aged persons. In children it is of a white colour, sometimes mixed with red; but in an advanced age its colour is generally dark.

The greatest part of the thymus lies between the duplicature of the superior and anterior portion of the mediastinum, and the great vessels of the heart; whence it reaches a little higher than the tops of the two pleuræ, so that some part of it is out of the cavity of the thorax; and in the fœtus and in children, it lies as much without the thorax as within it, and is then composed of numerous lobules, each inclosed in a thin covering, and united together by cellular substance: these are hollow within, and communicate together somewhat like the cells of the lungs, but they contain a milky fluid, which readily appears after an opening is made, but this fluid vanishes soon after birth.

Its particular inward structure and secretions are not as yet sufficiently known to determine its real uses; which, however, seem to be designed more for the fœtus than for adults.

PERICARDIUM.

The heart, with all the parts belonging to it, is contained in a membranous capsula, called *pericardium;* which is in some measure of a conical figure, and somewhat bigger than the heart; but the difference must be less during life when the heart is full of blood. It is not fixed to the basis of the heart, but round the large veins above the auricles before they send off the ramifications, and round the large arteries before their divisions.

The pericardium is made up of three laminæ; the middle and chief of which is composed of very fine tendinous filaments, which are best seen in old persons; they are closely interwoven and cross each other in different directions. The internal lamina seems to be a continuation of the outer coat of the heart, auricles, and great vessels. The trunks of the aorta and pulmonary artery have one common coat, which contains them both as in a sheath, and is lined on the inside by a cellular substance, chiefly in that space which lies between where the trunks are turned to each other, and the sides of the sheath. There is but a very small portion of the inferior vena cava contained in the pericardium.

It is the middle lamina which chiefly forms the pericardium; and the figure of this bag is not simply conical, its apex or point being very round, and the basis having a particular elongation which surrounds the great vessels, as has been already said, as amply as the other portion surrounds the heart.

The pericardium is closely connected to the diaphragm, not at the apex, but exactly at that place which answers to the flat or lower side of the heart; and it is a very difficult matter to separate it from the diaphragm in dissection, the tendinous fibres of the one substance intermixing with those of the other. This adhering portion is in some measure of a triangular shape, answering to that of the lower side of the heart; and the rest of the bag lies upon the diaphragm, without any adhesion.

The external lamina, or common covering, as it may be called more properly, is formed by the duplicature of the medi-

astinum. It adheres to the proper bag of the pericardium by the intervention of the cellular substance in that duplicature, but leaves it where the pericardium adheres to the diaphragm, on the upper surface of which it is spread, as being a continuation of the pleura.

The internal lamina is perforated by an infinite number of very small holes, through which a serous fluid continually transudes, in the same manner as in the peritonæum, there being no glands for this purpose, as some have supposed. This fluid being gradually collected after death, makes what is called *aqua pericardii*, which is found in considerable quantities in opening dead bodies while they remain fresh. Sometimes it is of a reddish colour, which may be owing to a transudation of blood through the fine membrane of the auricles.

OF THE HEART.

Situation in general and conformation. The heart is a muscular body situated in the cavity of the thorax, on the anterior part of the diaphragm, between the two laminæ of the mediastinum. It is in some measure of a conical figure, flatted on the sides, round at the top, and oval at the basis. Accordingly we consider in the heart, the basis; the apex; two edges, the one right and the other left; and two sides, one of which is generally flat and inferior, the other more convex and superior.

Besides the muscular body, which chiefly forms what we call the *heart*, its basis is accompanied by two appendices, called *auriculæ*, and by large blood-vessels; of which hereafter: and all these are included in the pericardium.

The heart is hollow within, and divided by a septum which runs between the edges into two cavities, called *ventriculi*, one of which is thick and solid, the other thin and soft. This latter is generally termed the *right ventricle*, the other the *left ventricle*; though, in their natural situation, the right ventricle is placed more anteriorly than the left, as we shall see herehereafter.

Each ventricle opens at the basis by two orifices; one of which answers to the auricles, the other to the mouth of a large

artery; and accordingly one of them may be termed the *auricular orifice*, the other the *arterial orifice*. The right ventricle opens into the right auricle, and into the trunk of the pulmonary artery; the left into the left auricle, and into the great trunk of the aorta. At the edges of these orifices are found several moveable pelliculæ, called *valves*, of which some are turned inward toward the cavity of the ventricles, called *tricuspid*; others are turned toward the great vessels, called *semilunar*, or *sigmoid*. The tricuspid valves of the left ventricle are likewise termed *mitral*.

Ventricles. The inner surface of the ventricles is very uneven, many eminences and cavities being observable therein. The most considerable eminences are thick fleshy productions, called *columnæ carneæ*, fleshy columns. To the extremities of these pillars are fastened several *chordæ tendineæ*, tendinous cords, the other ends of which are joined to the valvulæ tricuspides. There are likewise other small short tendinous ropes along both edges of the septum between the ventricles. These small cords lie in an obliquely transverse situation, and form a kind of net-work at different distances.

The cavities of the inner surface of the ventricles are small deep fossulæ or lacunæ placed very near each other, with small prominent interstices between them. The greatest part of these lacunæ are orifices of the venal ducts, to be described hereafter.

Structure of the ventricles. The fleshy or muscular fibres of which the heart is made up, are disposed in a very singular manner, especially those of the right or anterior ventricle; being either bent into arches or folded into angles.

The fibres which are folded into angles are longer than those which are only bent into arches. The middle of these arches, and the angles of the folds, are turned toward the apex of the heart, and the extremities of the fibres toward the basis. These fibres differ not only in length, but in their directions, which are very oblique in all, but much more so in the long or folded fibres than in the short ones, which are simply bent.

It is commonly said that this obliquity represents the figure 8; but the comparison is very false, and can only agree to

some bad figures drawn by persons ignorant of the laws of perspective.

All these fibres, regard being had to their different obliquity and length, are disposed in such a manner, as that the longest form partly the most external strata of the convex side of the heart, and partly the most internal on the concave side; the middle of the arches and the angles meeting obliquely and successively to form the apex.

The fibres situated within these long ones grow gradually shorter and straighter all the way to the basis of the heart, where they are very short and very little incurvated. By this disposition, the sides of the ventricles are very thin near the apex of the heart, and very thick toward the basis.

Each ventricle is composed of its proper distinct fibres; but the left ventricle has many more than the right, its substance being considerably thicker. Where the two ventricles are joined, they form an impervious septum which belongs equally to both. Opposite to this septum a groove is seen on the outside of the heart; one running longitudinally on its upper, the other on its under surface: in these grooves the great branches of the coronary arteries and veins are lodged.

There is this likewise peculiar to the left ventricle, that the fibres which form the innermost stratum of its concave side, form the outermost stratum of the whole convex side of the heart, which consequently is common to both ventricles; so that, by carefully unravelling all the fibres of the heart, we find it to be made up of two bags contained in a third.

The anterior or right ventricle is somewhat larger than the posterior or left, as well observed by the ancients, and clearly demonstrated by M. Helvetius. The left is a little longer than the right, and in some subjects they end exteriorly in a kind of double apex. But it appears from experiments, that the inequality between the parts of the right and those of the left side of the heart, are not so great during life as after death; for, in the hearts of animals killed by cutting across the vessels of the neck, and in those of persons who have died in battle from a wound in the vena cava or pulmonary artery, the inequality is less

than we commonly perceive. This was first observed by M. Vieussens Professor of Anatomy at Altorf.

Sabatier has made numerous experiments on animals; the the result of which is nearly the same with that mentioned above.

All the fibres are not directed the same way, though they are all more or less oblique: for some end toward the right hand, others toward the left, some forward, some backward, and others in the intermediate places; so that, in unravelling them, we find that they cross each other gradually, sometimes according to the length of the heart, and sometimes according to its breadth.

The tubes which cross each other transversely are much more numerous than those which cross longitudinally; which ought to be taken notice of, that we may rectify the false notions that have been entertained concerning the motion of the heart; namely, that it is performed by a contortion or twisting like that of a screw, or that the heart is shortened in the time of contraction, and lengthened in dilatation.

The fibres which compose the inner or concave surface of the ventricles do not all reach to the basis; some of them running into the cavity, and there forming the fleshy columns, to which the loose floating portion of the tricuspidal valves is fastened by tendinous cords.

Besides these fleshy pillars, the internal fibres form a great many eminences and depressions, which not only render the inner surface of the ventricles uneven, but give it a great extent within a small compass. Some of these depressions are the orifices of the venal ducts found in the substance of the ventricles, which have been already mentioned. The circumferences of the great openings at the basis of the heart are tendinous, and may be looked upon as the common tendon of all the fleshy fibres of which the ventricles are composed.

Valves. The valves at the orifices of the ventricles are of two kinds: one kind allows the blood to enter the heart, and hinders it from going out the same way; the other kind allows the blood to go out of the heart, but hinders it from returning.

The valves of the first kind terminate the auricles; and those of the second lie in the openings of the great arteries. The first are termed *semilunar* or *sigmoid valves;* the others, *tricuspidal*, or *mitral*.

The tricuspidal valve of the right ventricle is of a circular form, and is fixed to the opening of the auricle, while the other end is attached to the internal surface of the ventricle. The circular membrane of the valve soon divides into many parts, three of which are more considerable than the rest; and these have got the name of *tricuspid valves*, though they are now generally considered as forming one. That which is next the mouth of the pulmonary artery is the largest, and is said by some to prevent the blood from getting into the artery while the ventricle is filling. It has three triangular productions, very smooth and polished on that side which is turned towards the auricle; and on the side next the cavity of the ventricle, they have several membranous and tendinous expansions, and their edges are notched or indented. The valve of the auricular orifice of the left ventricle is of the same shape and structure, but it is only divided into two parts; and, from some small resemblance to a mitre, has been named *mitralis*. That which is next the mouth of the aorta is the largest.

The semilunar valves are six in number, three belonging to each ventricle, situated at the mouths of the great arteries; and they may be properly enough named *valvulæ arteriales*. Their concave sides are turned toward the cavity of the arteries, and their convex sides approach each other. In examining them with a microscope, we find fleshy fibres lying in the duplicature of the membranes of which they are composed.

They are truly semilunar, or in form of a crescent, on that side by which they adhere; but their loose edges are of a different figure, each of them representing two small crescents; the two extremities of which meet at the middle of this edge, and there form a kind of small papilla, first described by Arantius, and afterward by Morgagni, and therefore named from them.

The great artery that goes out from the left ventricle, is termed *aorta*. At the beginning of the aorta, and behind the semi-

lunar valves, three elevations are observed on the outside: these correspond to an equal number of pits on the inside, which, from the discoverer, have been called *sinuses of Valsalva.* Their use is not well known.

The trunk of the artery which goes out from the right ventricle, is called *arteria pulmonaris.* This trunk, as it is naturally situated in the thorax, runs first of all directly upward for a small space; then divides laterally into two principal branches, one for each lung; that which goes to the right lung being the longest, for a reason that shall be given hereafter.

Auricles. The auricles are muscular bags situated at the basis of the heart, and their capacities are in proportion to those of their respective ventricles; one toward the right ventricle, the other toward the left, and joined together by an inner septum and external communicating fibres, much in the same manner with the ventricles; one of them being named the *right auricle*, the other the *left.* They are very uneven on the inside, but smoother on the outside; and terminate in a narrow, flat, indented edge, representing a cock's comb, or in some measure the ear of a dog; this properly gets the name of *auricle*, the larger and smooth part of the cavity being called *sinus venosus*, but as the two parts make one general cavity, the name of *auricle* is commonly applied to the whole. They open into these orifices of each ventricle, which I name *auricular orifices;* and they are tendinous at their opening, in the same manner as the ventricles.

The right auricle is larger than the left; and it joins the right ventricle by a common tendinous opening, as has been already observed. It has two other openings united into one, and formed by two large veins which meet and terminate there, almost in a direct line, called *vena cava superior* and *inferior.* Highmore has described an eminence in form of a valve, placed between the mouths of the two venæ cavæ: this he supposed directs the blood from the veins into the auricle; afterward Lower described and delienated it; and other anatomists have called it *tuberculum Loweri,* till Morgagni denied its existence in the human subject. At the mouth of the inferior cava we

find a membrane in form of a crescent, described by Eustachius, and named from him. Its convex edge is fixed to the union of the vein and the right auricle, while its concave edge is turned upward over the mouth of the vein. It is most complete in the fœtus; but it is found likewise in a person of advanced age, though it sometimes, from use, has a reticular appearance. It is said to prevent the blood in the auricle from returning into the cava; but it has a different use in the fœtus. The notched edge of this auricle terminates obliquely in a kind of obtuse point, which is a small particular production of the great bag, and is turned toward the middle of the basis of the heart.

The whole inner surface of the right auricle is uneven, by reason of a great number of prominent lines which run across the sides of it, and communicate with each other by smaller lines, which lie obliquely in the interstices between the former. The lines of the first kind represent trunks, and the other, small branches in an opposite direction to each other: these are called *musculi pectinati*. In the interstices between these lines, the sides of the auricle are very thin and almost transparent, seeming to be formed merely by the external and internal coats of the auricle joined together, especially near the point.

The left auricle is in the human body a kind of muscular bag or reservoir, of a pretty considerable thickness and unequally square, into which the four veins open called *venæ pulmonares*, and which has a distinct appendix belonging to it, like a third small auricle. This bag is very even on both surfaces, and is therefore called *sinus venosus;* but to distinguish it from the one on the right side, it is called *sinus venosus sinister*. However, the bag and appendix have but one common cavity; and therefore may still be both comprehended under the common name of the *left auricle*. In men, the small portion may likewise be named *the appendix of the teft auricle;* but in other animals, the case is different.

This small portion or appendix of the left auricle is of a different structure from that of the bag or large portion. Exteriorly, it resembles a small oblong bag, bent different ways, and indented quite round the edges. Interiorly, it is like the inside of the right auricle. The whole common cavity of the left auricle

is smaller in an adult subject than that of the right; and the fleshy fibres of this left auricle cross each other obliquely, in strata differently disposed.

Coronary arteries and veins. Besides the great common vessels, the heart has vessels peculiar to itself, called *the coronary arteries* and *veins*, because they in some measure crown the basis of the heart. The coronary arteries, which are two in number, go out from the beginning of the aorta, and afterward spread themselves round the basis of the heart, to the substance of which they send numerous ramifications.

Vieussens believed that some of the branches of the coronary artery opened into the cavities of the ventricles and auricles; for by throwing a fine injection into these arteries, he found it run out on all sides of the right ventricle and auricle. Thebesius of Allemand, being nearly of the same opinion, endeavoured to prove, that there were veins which carried part of the blood from the coronary arteries immediately into the cavities of the heart; and these have therefore got the name of *veins of Thebesius*, though he is not the first discoverer. Winslow, Haller, and several others, describe such veins; but Duverney, after injecting the heart of an elephant, doubts of their existence. Senac, who has paid much attention to this subject, denies it altogether; and Sabatier coincides with him in opinion.

There are seldom more than two arteries; of which one lies toward the right hand, the other toward the left of the anterior third part of the circumference of the aorta. The right coronary artery runs in between the basis and right auricle, all the way to the flat side of the heart, and so goes half way round. The left artery has a like course between the basis and left auricle; and before it turns on the basis, it sends off a capital branch, which runs in between the two ventricles. Another principal branch goes off from the union of the two arteries on the flat side of the heart; which running to the apex, there joins the other branch.

The coronary veins are distributed exteriorly, much in the same manner. The largest opens into the posterior inferior part of the right auricle, by an orifice which is furnished with a valve, first described by Eustachius. Besides the coronary

veins, the heart has other anterior veins, which have been called by Vieussens *venæ innominatæ*. Some of them go into the right auricle, others end in the right ventricle; and there are other veins still smaller, which are found in the substance of the heart, and which terminate in the right sinus and auricle.

Particular situation of the heart. The heart lies almost transversely on the diaphragm, the greatest part of it being in the left cavity of the thorax, and the apex being turned toward the bony extremity of the sixth true rib. The basis is toward the right cavity; and both auricles, especially the right, rest on the diaphragm; but the situation of the heart during life changes a little, according to the state of respiration, and to the position of the body.

The origin or basis of the pulmonary artery is, in this natural situation, the highest part of the heart on the foreside; and the trunk of this artery lies in a perpendicular plane, which may be conceived to pass between the sternum and spina dorsi. Therefore some part of the basis of the heart is in the right cavity of the thorax; and the rest, all the way to the apex, is in the left cavity; and it is for this reason that the mediastinum is turned toward that side.

According to this true and natural situation of the heart, the parts commonly said to be on the right side or rather anterior, and those on the left side posterior; and that side of the heart which is thought to be the foreside is naturally the upper side, and the backside consequently the lower side.

The lower side is very flat, lying wholly on the diaphragm; but the upper side is a little convex through its whole length, in the direction of the septum between the ventricles.

Uses in general. The heart and parts belonging to it are the principal instruments of the circulation of the blood. The two ventricles ought to be considered as two syringes so closely joined together as to make but one body, and furnished with suckers placed in contrary directions to each other, so that by drawing one of them, a fluid is let in, and forced out again by the other.

The heart is made up of a substance capable of contraction

and dilatation. When the fleshy fibres of the ventricles are contracted, the two cavities are lessened in an equal and direct manner, not by any contortion or twisting, as the false resemblance of the fibres to a figure of 8 has made anatomists imagine. For if we consider attentively in how many different directions and in how many places these fibres cross each other, as has been already observed, we must see clearly, that the whole structure tends to make an even, direct, and uniform contraction, more according to the breadth or thickness than according to the length of the heart ; because the number of fibres situated tranversely, or almost transversely, is much greater than the number of longitudinal fibres.

The fleshy fibres thus contracted do the office of suckers, by pressing upon the blood contained in the ventricles ; which blood being thus forced toward the basis of the heart, presses the tricuspid valves against each other, opens the semilunar, and rushes with impetuosity through the arteries and their ramifications, as through so many elastic tubes.

Systole. The blood thus pushed on by the contraction of the ventricles, and afterward pressed by the elastic arteries, enters the capillary vessels, and is thence forced to return by the veins to the auricles, which receive and lodge the blood returned by the veins during the time of a new contraction. This contraction of the heart is by anatomists termed *systole.*

Diastole. The contraction or systole of the ventricles, ceases immediately, by the relaxation of their fleshy fibres ; and in that time the auricles which contain the venal blood, being contracted, force the blood through the tricuspidal valves into the ventricles, the sides of which are thereby dilated, and their cavities enlarged. This dilatation is termed *diastole.*

Circulation. In this manner does the heart, by the alternate systole and diastole of its ventricles and auricles, push the blood through the arteries to all the parts of the body, and receive it again by the veins. This is called the *circulation of the blood.* which is carried on in three different manners.

The first and most universal kind of circulation is that by which almost all the arteries of the body are filled by the systole

of the heart, and the greatest part of the veins evacuated by the diastole.

The second kind of circulation opposite to the first, is through the coronary vessels of the heart, the arteries of which are filled with blood during the diastole of the ventricles, and the veins emptied during the systole.

The third kind of circulation is that of the left ventricle of the heart; through the venal ducts of which a small quantity of blood passes, without going through the lungs, which is the course of all the remaining mass of blood.

Besides these three different kinds of circulation, there are some peculiarities in the course of the blood, which may be looked upon as particular circulations. Such is the passage of the blood through the liver, corpora cavernosa of the parts of generation, and through the cavernous sinuses of the dura mater.

The veins which carry back the blood from the whole body to the heart, if we except those of the lungs, are reducible to two, which are the venæ cavæ.

The blood of the two venæ cavæ is propelled by a muscular force, in either vein, into the right auricle. These veins, as far as they lie within the breast, are endowed with strong and irritable muscular fibres, by whose contraction the blood is driven into the neighbouring auricle.

In like manner, the auricle, being irritated, is contracted on all sides. And, first, by a constriction of its muscular fibres, the anterior semicylinder of the auricle is reduced to a plane; while the same fibres, by their contraction, bring back the middle arch toward the anterior extremity or beginning of the heart, and likewise toward its posterior extremity or sinus. Then the appendix to the auricle descends, and is contracted transversely by itself, while the lower part ascends; and thus the auricle becomes shorter. Again, the left edge turns evidently to the right, and the right edge a little to the left; and thus the auricle is rendered narrower. Thus the blood of both cavæ, being mixed together in the beginning of the heart now disencumbered, is driven through the edges of the open valve, in such a manner as to urge the valves of the right ventricle

close to the sides of the heart. But the blood is now hindered from returning again into the lower cava, both by the contraction of the auricle, the resistance of the succeeding blood from the abdomen, and of the *Eustachian valve;* and upwards it is hindered from ascending, both by the motion and weight of the consequent blood. It is driven back, however, on both sides, if there happens to be any obstacle in the lungs.

The usefulness of the tricuspid valves is evident enough; for the right auricle being contracted, the blood contained in the right sinus of the heart, at the loose extremity of the auricle, being impelled from the circumference toward the axis, like a wedge, separates the pendulous portions of the valves, and presses them to the sides of the heart. Thus is filled the right ventricle of the heart, while the uppermost valve shuts the pulmonary artery, lest the blood, by the weak impulse of the auricle, should flow into that artery: the blood thus received, and confined within the right ventricle of the heart, is, by the strong contraction thereof, more powerfully expelled into the artery.

The sensible flesh of the heart, being irritated by the quantity and weight of this warm blood, is thereby solicited to a contraction: for that the heart, being irritated, will contract itself in a person dying, or even lately dead, is proved by injections of water, and inflations of air, whereby the heart, then quiescent, is recalled to its motion.

The heart's motion is performed by *muscular fibres;* the originations of which, in general, are from rings formed of the cellular substance, compacted into a callous ligament, agreeable to the description already given, and with which all the larger blood-vessels at their opening into the heart are surrounded. Thence the fibres, which arise, descend gradually in an oblique winding course toward the left side, and forward to the apex, in many distinct plates, and sometimes a little traversing each other, the middle ones being the most transverse, while the outermost and innermost descend in a straighter line. In the flat side of the heart there are few fibres; and so thin, that when you have removed the fat, the cavity appears almost uncovered. That which is called the left ventricle, is, however, very firmly

invested by the fibres; which, after surrounding the same ventricle, form a slight decussation in the septum cordis with the fibres of the right ventricle, and are interwoven with them. Some of these fibres descend into the cavities of the ventricles, and form there the fleshy columns. Others at the tip of the heart, are wound in a vortical or whirling position, the two horns ending by a strong fasciculus or bunch in each ventricle. A very thin and smooth membrane covers the external and internal surface of these fibres; but the external membrane, especially where it is spread over the coronary vessels, contains much fat beneath it. It is difficult to distinguish any thing more particular in the muscular fabric of the heart, with any tolerable degree of evidence; because it is the peculiar property of the fibres in the heart to join together in branchy appendices or heaps, in so strict union, that they cannot be separated without laceration.

These fibres of the heart, like other muscles, are furnished with *nerves* of their own, very numerous and of various origin.

That these nerves conduce powerfully to move the heart, is the opinion of eminent anatomists, from a consideration of the common nature of muscles; and from the increase which follows in the heart's motion, by irritating the eighth pair of nerves, either at the brain or the spinal medulla; and from the languor that ensues upon tying those nerves, which proves fatal, either suddenly or within a few days, even though you happen to make the ligature on but a few of the nerves that come to the heart; for the intercostal, and especially those from the ganglion of the upper thoracic, cannot be tied.

But it is by means of the stimulus of the impulse of the venous blood, that the heart contracts itself; and this contraction is convulsive, made with great celerity, and a manifest corrugation of the fibres; whereby the whole heart becomes shorter, thicker, and harder; so that the left ventricle is drawn somewhat toward the septum of the heart, and the right one much more. The base also advances towards the apex; but the apex more evidently toward the basis. Even the septum of the heart is rendered shorter, and draws itself towards the basis. By this action, the fleshy parts of the heart swell inwardly, and compress the blood as they do the finger, when introduced into its cavities.

But that the heart is accurately enough emptied in this action, appears from the event; the evident paleness of animals whose heart is white, as frogs and chickens; and from the internal surface being full of eminences, which exactly answer to opposite cavities. And besides, the apex of the heart, being contracted a little like a hook, strikes against that part of the pericardium next the thorax. Forwards, there is also a pulsation from the left venal sinus; which is at that time particularly filled. In exspiration, the heart strikes violently upwards and forwards. The truth of both these we know by experiment.

The blood, which is pressed by the contracted heart, endeavours to escape in all directions; but being driven from the muscular sides, towards the axis of the ventricle, by the reaction of what is lodged betwixt the venal ring and sides of the heart, the looser ends of the said ring are driven forward and extended inward at the same time. By this action upon the whole circumference of the ring, it not only becomes extended itself, but, at the same time, rejects a part of that blood into the right auricle, which had before descended into the cone of the open valve, whose sides, now approaching, shut up the venous orifice more closely as the heart contracts more strongly; by whose force the tricuspid valves, as they are called, would be pressed into the auricle, if the muscular columns did not keep down their edges, and hold them firmly by their contraction (which is the same with that of the heart) in such a shape as will extend the annexed cords of the valve, without injuring them.

But the nisus of the remaining blood, now resisted by the tricuspids, seeks another course; and whilst the larger of those valves that is seated to the right, advances from the side toward the axis of the heart, this leaves open the mouth of the pulmonary artery, which it before covered; whereupon the blood pressing the valves in the mouth of the said artery close to its sides thus rushes into it.

Each of these valves, in conjunction with the sides of the artery here diverging, intercepts a space, which is blind or impervious downward, but open upward in a parabolical shape, as we shall find in the valves of the veins. When, therefore, the blood

is impelled from the sides toward the axis of the contracting heart, it endeavours to escape in the direction of the said axis; and, by rushing forth like a wedge, betwixt the valves, presses their loose edges against the sides of the pulmonary artery, so as to run freely out of the heart. The truth of this appears from the fabric, from injections, and from ligatures, which, by obstructing the lungs, will not suffer the large cavities in the right side of the heart to be emptied.

The blood now received into the pulmonary artery, goes on then to make its circulation through the lungs. That artery is first divided into two branches; of which the left, being less and shorter, enters directly into the substance of the lungs: but the right branch, being larger and longer, passes transversely through the arch of the aorta; and, after going a little way behind the said aorta, enters the corresponding lungs of the same side. From each of these branches, by a multiplied subdivision, arise the very least arteries; some of which transmit the blood directly into the continued small veins, and others exhale part of its aqueous juices into the pulmonary cells. That the blood goes thus directly from the arteries into the pulmonary veins, appears evidently from their structure; also from a ligature, which intercepting the blood's course, while the heart and lungs still urge it, causes an aneurismatic dilatation of the artery; and from injections, which are very easily forced from the pulmonary artery into the vein, and thence into the left cavity of the heart. But the direct anastomoses or final openings of the arteries into the veins in the lungs, is proved even to the sight by the microscope, in frogs, &c.

Nor can the blood which has once entered the pulmonary artery return back again upon the heart; because the valves therein are of such dimensions, that when distended, they perfectly shut up the opening at the heart; and are so strong that they resist a much greater force than the contraction of the pulmonary artery, without being constrained to yield. However, sometimes, from a greater contractile force of the artery, they grow somewhat callous; or, from a laceration of their outer membrane, a bony matter is poured in betwixt the duplicature of the valves. For, when the blood, by the contraction of the artery, returns

toward the heart, it meets and enters the open concavities of the valves, which are by that means expanded, and driven together toward an axis in the middle: whence the valves, once expanded, quite shut up the mouth of the artery, so as to leave not the least slit open; for any opening that might be left, is precluded by the small callous bodies remarked in the middle of the valves.

The *pulmonary veins*, of which we shall say more hereafter, gather into larger branches, which at last terminate in four (seldom two, and still more rarely into five) trunks; to which it has been customary to affix a name in the singular, by calling them the *pulmonary vein*. These enter the cavity of the pericardium, whence they receive an external covering; and are then inserted at angles into the square left or posterior sinus, which is sometimes likewise called the *pulmonary sinus*. In this course the upper veins descend as the lower ones ascend. But that these veins bring their blood toward the heart, in the same direction with the sinus into which they open, is proved by a ligature, which causes a turgescence or swelling, from the blood retained, betwixt the ligature and the lungs.

In this left sinus, the blood waits for the heart's relaxation; at which time the nisus of the blood impelled against the venous valves, and the contracting stronger force of the sinus, grow less. Then the left sinus stretches itself forward across the heart, is contracted transversely along with it, and the appendix becomes evidently shorter and narrower. Thus the blood is driven into the left ventricle, in like manner as the right auricle impelled its blood into the right ventricle. For here, as before, a like membranous oval ring forms productions called *mitral valves*, of which there are usually two only counted. These valves are longer and stronger than those of the right ventricle. They have each its own and separate muscular structure; but it is much firmer than that of the tricuspids. And here, more often than in the valves on the right side, we find cartilaginous tumors in the tendinous strings, produced by the friction occasioned by the great motion of the heart.

From what has been said then, it appears that the same blood is now arrived into the left ventricle of the heart, which

was a little before sent from the venæ cavæ into the right auricle, which drove it into the corresponding or right ventricle; by which again it was urged into the pulmonary artery; and thence passing into the pulmonary veins, was conveyed into the left sinus; and out of this we here find it driven into the left ventricle. This course of the blood, from one side of the heart to the other through the lungs, is called the *pulmonary* or *lesser circulation*, and was known to many of the ancients. It is proved by the increased bulk of the pulmonary veins on the left side; and likewise of the right cavities of the heart, from an obstruction of the entrance into the left ventricle.

The *left*, or posterior and upper *ventricle* of the heart, which is always first formed, and in a great number of animals the only one, makes up that part of its half cone-like body, which we before called *obtuse*. It is somewhat narrower than the right ventricle, a little longer, rounder, and generally of a less capacity within, says Dr. Haller: for the contents of this ventricle are about two ounces, while those of the right approach to three. Its fabric internally is reticular, but more nicely wrought than in the right ventricle; and within the mouth of the artery it is smooth: but its force is considerably greater, as the muscular flesh that surrounds it is much thicker and almost three times stronger. The septum of the heart belongs mostly to the left, but some part of it also to the right ventricle: the whole of it is reticulated in like mauner; but solid, and incapable of suffering any injected liquid to pass from one ventricle to another.

Again, this left ventricle being instigated to motion by the impelled blood, does, from the same irritable nature already mentioned, contract, and drive its contained blood with a violent motion in the direction of its axis, and determine it toward the basis, at the time when the tip or cone of the heart is drawn nearer to its basis. And since the apparatus of the mitral valves is here the same as in the tricuspids, the venous blood now expanding the ring whence they arise, removes that valve which lay against the mouth of the aorta, so as to open a way for itself to the artery; in dilating the mouth of which, the said blood presses the semilunar valves, there placed, against the sides of the aorta, into which it rushes with a violent impetus. This is

proved by ocular demonstration in living animals, where the left ventricle swells upon shutting the passage into the aorta.

The *semilunar valves of the aorta* differ little from those in the pulmonary artery: only as the opening is here greater, so the valves are proportionably larger and stronger, and are not so often found to want those callous round bodies in the middle. The fibres too of the valves, both transverse and ascending, are here somewhat more conspicuous.

After the contraction of the heart, follows its relaxation or diastole, in which it becomes empty, lax, and soft, recovers its former length, the ventricles recede from the septum, and the basis from the apex. But, while it is in this state, the blood in the auricles, having been as it were in a state of expectation, rushes through the openings of the valves of the veins, dilates the opposite sides of the heart, and makes it at once longer and larger. After the auricles have freed themselves of the blood they contained, they are in like manner relaxed, and their opposite sides remove from each other. Then the blood collected in the venæ cavæ and pulmonary veins, fills the auricles by the contraction of the veins; renders them long, broad, and thick, like the ventricles; and even distends and fills the processes of the crested margin. That the fibres of the heart are not dilated, is proved from the junction of those fibres; which, being tied together by their middle branches, cannot be separated: also, by the dissections of live animals, in which the whole heart is shown to be contracted.

But we must now consider, that these motions of the right and left auricle, with the right and left ventricle, are not performed in that succession in which, for the sake of method, we have here described them; for both the auricles are contracted, while the ventricles are relaxed: so that the contraction of the auricles precedes the contraction of the ventricles; as we are assured from manifest experiments on dying animals, and on those whose living blood is cold. But both auricles are filled together in the first instant, as both of them are emptied together in the second instant; and both the ventricles are contracted together in the third instant, which is the same with the first; and both ventricles being evacuated, are relaxed in the fourth instant, which is the same with the second. That the

auricle, near death, makes frequent palpitations before the ventricle of the heart performs one contraction, is true enough. The auricle with its sinus forms one cavity, and both are filled and both emptied in the same instant.

Haller is of opinion, that the mere stimulus of the blood excites and perpetuates the action of the heart.

But with what celerity, and with what force the heart drives forward the blood, is controverted and variously computed. The more modern writers have raised their calculations upon a supposition, that, for the celerity to be determined, we are to admit two ounces of blood to issue out of the heart with such a celerity, that the part of the pulse called its *systole*, makes one third of the whole pulsation, and is finished within a $\frac{1}{225}$ part of a minute; but the area of the mouth of the aorta, they have estimated 0.4157 parts of an inch: so by dividing the space filled by two ounces of blood (3.315 inches), by the area or section of the aorta at its mouth [and length of its cylinder filled by two ounces, viz. $= 7\frac{29309}{33180}$], the number thence produced divided by $\frac{1}{225}$, the time in which the heart contracts, they find 149 feet and two-tenths of an inch for the space through which the blood runs in a minute, if it goes on in a cylinder with the same velocity it first had from the heart. But the incumbent weight of blood moved by the heart, they have computed by the jerk wherein the blood starts forth from the larger arteries in a living animal, being seven feet five tenths; and from the surface of the ventricle, whose area makes 15 inches. Thus 1350 cubical inches of blood, or 51 pounds five ounces, circulate, which press against the ventricle of the contracting heart. The heart, therefore, thus drives forward a weight of 51 pounds with a velocity by which it may run through 149 feet in a minute; which force it exerts four thousand eight hundred times in an hour.

Although there are many particulars here unthought of which may render the estimate incomplete, and such perhaps as we may never ascertain; and although the mouth of the distended aorta may be wider in a living animal, though the area of the ventricle is of uncertain dimensions, and the jerk of blood com-

puted from an insufficient height; yet if we consider the violence with which the blood starts from some of the least sanguine arteries in the living animal, although we cannot easily determine how much of the heart's systole is thus spent, variations in which will greatly alter the computation; yet, in the mean time, it will plainly appear that the machine we call the *heart*, is a very powerful one. The truth of this is evident from experiments; in which it appears to be very difficult to fill all the red blood-vessels by anatomical injections, and quite impossible to fill all the smaller ones; yet the heart, we see, not only gradually distends all the larger, the smaller, and even the least vessels, with blood, but also drives it forward through them with a considerable celerity. Even in the least arteries, the blood is urged forward by the heart with such a force as to make the alternate motions of that muscle perceptible. Likewise, in the veins and smaller vessels of cold animals, even while contained in the insect's egg, there is no other force besides that of the heart, by which the blood is driven through their small vessels. And, from some of the least arteries, I have seen the blood start forth several feet, the jerk describing a parabola, whose height was four feet, and amplitude of projection seven feet; and some assert, they have seen the blood ascend from the aorta to the height of twelve feet.

Moreover, that we may make a just estimate of the heart's force in living animals, we must consider what great resistances that complex muscle overcomes: we must compute the enormous weight there is of the whole blood; a mass perhaps of fifty pounds and upwards: for all that quantity of fluids, once stagnant in a person lately drowned or fainted away, are easily put into their former motion by the heart only. We must again consider the great decrease of the blood's velocity, arising from the greater light or capacity of the dividing branches (from whence the ratio of its celerity, even in the intestines, may be computed to only a 24th or a 30th part of its original impulse), abates two-thirds from the heart's force. And yet we see there are humours swiftly moved through the most minute vessels; as, for example, the Sanctorian perspiration, which in a subterraneous cavern is observed to ascend swiftly in form of smoke

or vapour; and the same celerity of the blood in the least vessels of little fishes, &c. is apparent to the eye by a microscope. Now since the frictions in every machine always consume the greatest part of the moving forces; much more do they in the human body, whose blood and juices are so much more viscid than water, and driven through vessels so small, that they permit a globule only at a time to pass through, and even hardly allow that without changing their figure: but from so strong and extended a friction there must necessarily follow a very great hindrance to the motion; whence we may easily understand, that the force must be very great, which drives so swiftly such a prodigious mass of fluids in spite of so many resistances and decrements of the moving forces. But, more than that, aneurisms and arteries are burst, and very great weights, as well as the body itself, raised, by the force of the heart's systole.

The blood, being driven into the aorta, immediately finds the two openings of the coronary arteries, which lie next the arterial valves, but above them, or within the aorta: and in consequence of this, it rushes first of all into the said coronary arteries, by which the heart supplies itself with blood. These arteries are for the most part two; the right goes off between the aorta and pulmonary artery, and the upper and left one between the left auricle and the aorta. All the external arteries are surrounded with much fat; but their cavity is more intercepted with valves than that of other arteries. These arteries communicate, by inosculations of the small branches, every where about the septum and tip of the heart; but they no where make a complete ring round the heart. They terminate in a twofold manner.

The first termination of them is into the coronary veins, whose branches running in company with those of the arteries, have their trunks of necessity disposed in a different course.

There are some who will have the coronary arteries filled with blood, not by the contracting of the heart, but of the aorta in in systole: which they think must be a consequence of the retrograde angle of the blood's course here, and the paleness of the contracted heart, with a supposition that the valves of the

aorta cover or close the mouths of the coronary arteries. But the two last of these are disproved by experience; and the first, or retrograde course, can only impede or lessen, and not intercept, the flux into the heart: for the injections of wind or mercury into all the seminal and biliary vessels, demonstrate that the large retrograde angles, which the vessels often make there, do not hinder the fluids from taking, though they retard, their natural course. But a proof, still more evident, is, that the coronary artery has a pulse at the same time with all the other arteries in the body, and the blood starting from it makes a higher saltus at the time when the heart is contracting.

The circulation through the coronary vessels seems to be completed in the shortest space of time that can be necessary in any part, from the great velocity the blood receives from the heart itself, urging the same through its own substance. But that the whole contents of the vessels are cleared in each contraction, does not seem probable; for the blood-vessels of the heart do not look pale enough in that action to produce such an effect as an entire evacuation. There is a very free or open passage from the arteries of the heart into the cellular substance, or fat which surrounds it, the uses of those least or shortest veins which open obliquely through the surface of both the ventricles are to return the blood of those deeply seated small arteries, which have no corresponding veins.

The humours of the heart, which are thinner than blood, return by the valvular *lymphatic veins*, which accompany the coronary blood-vessels, and ascend toward the thoracic duct and subclavian vein; but they are to be very rarely seen, although they can be distinctly observed in brute animals.

OF THE NATURE OF THE BLOOD.

The liquor which is contained in the beating arteries and their corresponding veins, is called by one general name, the *blood*: which, to a loose examination, appears homogeneous, or of similar parts, red and coagulating throughout; and is observed to be redder in proportion to the strength of the animal: in a weak and famished one, the blood inclines to a yellow: it

hath a whiteness mixed with it, which comes almost totally from the chyle. But from various experiments it is certain that this animal liquor contains very different ingredients.

That fire is contained in the blood may be proved from its heat, which, in human blood, and that of some other animals, is from 92 to 100 degrees of Fahrenheit's thermometer, which is more than the mean degree of atmospherical heat, but less than the greatest.

After the volatile aqueous vapour and the fetid odour has dissipated, the blood of a healthy person spontaneously congeals into a scissile trembling mass; and with a less degree of heat than that of boiling water, (viz. 150 deg.) The principal part of this coagulated mass is the *crassamentum* or *cruor*, which has the red colour peculiar to itself, and gives it to the other parts of the blood. This, if it be not kept fluid by the attrition of a vital circulation, or some similar concussion, runs confusedly into a compact, but soft mass, like liver, merely by rest and a moderate degree of cold. It is either as a fluid or a solid, specifically heavier than water by near an eleventh part; and, when freed from its water, it is wholly inflammable. In a mass of healthy blood, one half or upward is red cruor: and, in strong laborious people, the serum makes only a third part; and is still more diminished in fevers, often to a fourth or fifth part of the mass.

Another white, somewhat yellowish part of the blood, separates from this coagulum, transuding, as it were, through its pores, and at last becomes a quantity, in which the coagulum sinks: this again seems, though not really so, a homogeneous liquor. This part of the blood is, in general, one thirty-eighth part heavier than water, and almost a twelfth part lighter than the red globular mass of crassamentum: this too, by a heat of 150 deg. and by a concussive motion, is coagulable into a much harder mass than the red cruor; and forms an indissoluble glue, a flesh like membrane, which at length shrinks up to a horn-like substance, or friable gum. From thence are formed the pleuritic crusts or skins, polypuses, and artificial membranes. Besides this coagulable albumen, simple water, of which there is the greatest portion, is latent in this serum; and

likewise a quantity of mucus, less capable of being drawn into threads than the red cruor; nor at the same time coagulable, like the albumen, by heats and acids. Hewson has discovered a second kind of lymph, which Krausius has also allowed; but this does not hurt the received opinion of the elements of the blood.

Besides these parts of which the blood appears to consist, without subjecting it to any violence, it contains in its substance a quantity of *sea salt*, which is discernible to the taste, and sometimes visible by the microscope. That there is *earth* in the blood is demonstrated from nutrition; and from a chemical analysis, whereby the earth appears to lodge in the most fluid, and especially in the oily parts of the blood. By some very late experiments, it appears that a considerable quantity of ferruginous earth, easily reducible into metal by the addition of oxigenous gas, is contained in the blood when calcined. Lastly, another part in the blood is *air* in an unelastic state, and that in a very considerable quantity: the existence of which air in the blood and serum is proved by the putrefaction and distillation, or by removing the ambient air from them by the pump. But we are not to think, from hence, that the blood-globules are bubbles full of air, for they are specifically heavier than the serum.

By viewing fresh blood in a small glass tube by a microscope, or by applying the same instrument, while it is yet moving in the veins of a warm living animal as a hen-chicken, or a cold one as a frog, we perceive in it globules; which doubtless, make that part *cruor* or *crassamentum*. The colour of these globules is red; and so much the deeper and more inclined to scarlet the stronger the animal is: and in the same proportion their number increases, when compared with the quantity of yellow serum. Their diameter is very small, being between $\frac{1}{2000}$ and $\frac{1}{3000}$ of an inch.

From the red part of the blood, fibres also are generated in abundance; from the serum, in smaller quantities. In quantity, they equal the 28th part of the whole mass. These are formed of the gluten; but in a living animal they are not to be

perceived by the microscope, which so easily renders visible the red globules.

The exact mass or quantity of blood contained in the whole body cannot be certainly computed. The weight of the mass of humours, however, is much greater than that of the solids; but many of them do not flow currently in the circulation, as the jellatine that lodges in most parts, and the fat. But if we may be allowed to form a judgment from those profuse hemorrhagies that have been sustained without destroying the life of the patient, with experiments made on living animals by drawing out all their blood, joined with the bulk of the arteries and veins themselves: from these principles, the mass of circulating humours will be at least fifty pounds; of which about twenty-eight will be true red blood, current in the arteries and veins: of which the arteries contain only four parts, and the veins nine.

Nor does the blood always contain the same, or a like proportion, of those elements or principles above mentioned: for an increased celerity, whether by laborious and strong exercises, a full age, fever, or otherwise, augments the crassamentum, with the redness, congealing force, and cohesion of the particles; and the hardness and weight of the concreted serum with the alkaline principles, are by the same means increased. On the other hand, the younger and less active the animal, and the more watery or vegetable the diet on which it is fed, the crassamentum of the blood is proportionably lessened, and its serum and mucus increased. Old age, again, lessens the crassamentum and the gelatinous part likewise.

The red globules of the blood are probably intended to generate heat, since they and animal heat are always in proportion; while the serum is more especially designed for nutrition.

From experiment, scarce any observable difference takes place between venous and arterial blood, either in colour, density, or any other known diversity. Sometimes, however, a most evident difference exists; for the bright colour of the arterial blood seems to distinguish it from the dusky dark-coloured blood of the veins; but this, in the plain example of the hatching of a chicken, arises from the deeper series of glo-

bules in the thicker vein. We have not therefore sufficient certainty of a difference in the blood of different vessels. However, the arterial blood is apparently of a more bright or splendid red, and having a greater degree of fluidity and proportion of watery parts, may so far differ from the venous darker coloured blood. But to clear up this, further experiments are requisite.

From one and the same mass of blood, driven into the aorto, are generated all the fluids of the human body; which, from their affinity to one another, are reducible to certain classes. The manner in which they are separated ought to be accounted for by the fabric or mechanism of the glands themselves.

OF THE CIRCULATION OR MOTION OF THE BLOOD THROUGH THE ARTERIES AND VEINS.

The arteries and veins contain either blood or lymph. The red blood fills the arteries and the veins, which we call *red*, or those of the first order, and which have their origin in the heart. These it so fills in a living person, that at sometimes they are very loosely and imperfectly distended by it, and at other times they are rendered very full and turgid. After death, the veins are found fuller of blood than the arteries; but the arteries of a dead body commonly contain only a small quantity of this fluid.

This distending blood, then, is rapidly moved through all the vessels of a living body. Experiments made upon living animals sufficiently evidence the impulse and rapidity with which the blood is moved, particularly through the arteries. The height to which blood from cut carotids ascended, according to Hale's calculation, Dr. Wrisberg saw confirmed in robust men who had been sentenced to die, to wit, about seven feet; with this difference, however, that in two examples the blood sprung higher from the vertebrals than from the carotids. In the larger trunks, it runs most swiftly; but in the least of them, somewhat slower. And, in the larger veins, the blood's celerity is less than in the arterial trunks, in the same proportion as the sections of the arteries are less than those of the veins, i. e. twice or almost thrice slower. Another argument of the circu-

lation, is the compressure and relation of a vein, whereby the motion of the blood is promoted from one valve to another. This motion of the blood is, in the veins, uniform or equable enough; but in the arteries it is alternately greater when the vessel is more dilated, and less when it is contracted. This is proved by ocular inspection in living animals.

That the motion which the blood describes, is a course through the sanguineous arteries into the veins, is discovered from experience. For, first, it is certain, that all the arteries and veins communicate or open one into the other; because often, from one, and that a small artery, all the blood shall run even until death, and make the flesh exceedingly pale; and this not only out of the wounded limb, but from the whole body. There are, therefore, of course, open ways, or anastomoses, by which the blood speedily flows from the venous into the arterial system.

That the blood, again, in the arteries, flows from the heart toward the extreme parts of the body, is proved by the microscope, and by a ligature on the artery of a living animal, and likewise by the fabric, mechanism, and proportion of the semilunar valves between the arteries and their corresponding ventricles. Whatever artery is stopped by a ligature, the swelling ensues in that part betwixt the heart and the ligature, whilst the other part is emptied beyond the ligature, which is the part of the artery more remote from the heart: neither has it there any pulsation; nor if it be there wounded, will it yield any blood.

Dr. William Harvey was the first who experimentally asserted the motion of the blood returning in the veins to the heart, in such a manner as to render the whole intelligible, and leave no room to doubt of it. And, first, the valves of the veins lead us to this truth: for the common use or office of these valves is, to determine the pressure that is given from any quarter upon the veins, towards the heart, by allowing no opportunity to the venous blood that has once entered the trunk, which they intercept, to flow back to the branches. For, since the covering spaces of the valves open upward toward the heart, the blood enters and expands them. Thus those parts of the valves which

project freely into the cavity of the vein, approach toward the axis, until the opposite sides by meeting together shut up the tube. They do not, indeed, every where shut up the whole cavity of the veins.

Another office of the valves in the veins seems to be for sustaining the weight of the blood, that its upper columns may not gravitate upon the lower; nor the blood, flowing through the trunks, make too great a resistance against that which follows it through the branches.

Moreover, the valves, placed in the right ventricle of the heart, have such a fabric that they freely permit blood, air, or wax, to pass from the venous trunks of the cava into the heart, but deny any reflux from the heart into the veins.

Again, ligatures, in a living person, may make the thing more evident. When the veins of the limbs are tied, either by design or accident, with the limb itself about the hams, arms, ancles, or wrists, the limb below the ligature swells, the veins fill and distend themselves, and when opened make a free discharge of blood; but at the same time nothing of this kind happens above the ligature, nor are any of the veins to be seen there. But if the arteries are tied at the same time with the veins, these last remain flaccid and empty; and, upon removing the ligature from the arteries, the veins are immediately filled.

Another proof we have in the *transfusions* of blood; in which all the blood from the arteries of one animal is urged into the veins of another exhausted of blood; whereby the heart, arteries, and empty veins of the latter become so turgid and well replenished, that they work the whole machine of the animal with a remarkable degree of vivacity, or even cause it to labour under a plethora.

But that the blood passes from the least arteries into the least veins, we are clearly taught by *anatomical injection;* where, by one arterial trunk, we easily fill all the arteries and veins, almost throughout the whole body; provided the liquor be watery or very fluid, so as to pass easily in the vessels of the head, mesentery, heart, and lungs.

Lastly, *the microscope* has put the matter beyond all doubt in

the pellucid tails, feet, and mesenteries, of animals; where we see that the blood, brought to the extreme parts by the arteries, is poured either into small veins continuous with the reflexed artery, or else goes through branches of the arterial trunk into the parallel communicating vein, by which it goes on to the parts nearest the heart. This is the way in which the blood passes as well into the least veins which are capable of receiving only one globule, as into those that are somewhat larger, being able to admit two or more globules to advance together. But that there is no spongy or parenchymous interposition betwixt the arteries and veins, in the general course of the circulation, is proved both from microscopes and injections. For if there were any such parenchyma or spongy mass betwixt the arteries and veins, the hardening injections would show it, by appearing extravasated in a like unshapen mass.

The circulation of the blood is, therefore, now received by every one as a medical truth; namely, that all the blood of the human body is carried through the aorta, from the left cavity of the heart, to the extreme parts or converging ends of the arterial branches; whence the whole mass is again transmitted into the least veins, which convey it to the larger, and from them into the cava and heart itself; in which course it perpetually runs during life.

LUNGS.

Situation in general and figure. The lungs are two large spongy bodies, of a reddish colour in children, greyish in adult subjects, and bluish in old age; filling the whole cavity of the thorax, one being seated in the right side, the other in the left, parted by the mediastinum and heart; and of a figure answering to that of the cavity which contains them, that is, convex next the ribs, concave next the diaphragm, and irregularly flatted and depressed next the mediastinum and heart.

Division and figure in particular. They are distinguished into the right and left lung; and each of these into two or three portions called *lobes*, of which the right lung has commonly three, or two and a half, and the left lung two. The right lung

is generally larger than the left, answerably to that cavity of the breast, and to the obliquity of the mediastinum.

At the lower edge of the left lung, there is an indented notch or sinus opposite to the apex of the heart, which is therefore never covered by that lung even in the strongest inspirations, and consequently the apex of the heart and pericardium may always strike against the ribs; the lungs not surrounding the heart in the manner commonly taught.

Structure. The substance of the lungs is almost all spongy, being made up of an infinite number of membranous cells, and of different sorts of vessels spread among the cells, in innumerable ramifications.

Coats. This whole mass is covered by a membrane continued from each pleura, which is commonly said to be double; but what is looked upon as the inner membrane, is only an expansion and continuation of a cellular substance, which shall be spoken of after I have described the vessels of this viscus.

Bronchia. The vessels which compose part of the substance of the lungs, are of three or four kinds; the principal of these are air-vessels and blood-vessels. The air-vessels make the chief part, and are termed *bronchia.*

These bronchia are conical tubes, composed of an infinite number of cartilaginous fragments, like so many irregular arches of circles, connected together by a ligamentary elastic membrane, and disposed in such a manner as that the lower easily insinuate themselves within those above them.

They are lined on the inside by a very fine membrane, which continually discharges a mucilaginous fluid; and in the substance of the membrane are a great number of small blood-vessels, and on its convex side many longitudinal lines, which appear to be partly fleshy, and partly made up of an elastic substance of another kind.

The bronchia are divided in all directions into an infinite number of ramifications, which diminish gradually in size; and as they become capillary, change their cartilaginous structure into that of a membrane. Besides these very small extremities of this numerous series of ramifications, we find that all the subor-

dinate trunks, from the greatest to the smallest, send out from all sides a vast number of short capillary tubes of the same kind.

Vesiculæ bronchiales. Each of these numerous bronchial tubes is widened at the extremity, and thereby formed into a small membranous cell commonly called *a vesicle.* These cells or folliculi are closely connected together in bundles; each small branch producing a bundle proportionable to its extent and the number of its ramifications.

Lobuli. These small vesicular or cellulous bundles are termed *lobules;* and as the great branches are divided into small rami, so the great lobules are divided into several small ones. The cells or vesicles of each lobule have a free communication with each other, but the several lobules do not communicate so readily.

Interlobular substance. The lobules appear distinctly to be parted by another cellulous substance, which surrounds each of them in proportion to their extent, and fills up the interstices between them. This substance forms likewise a kind of irregular membranous cells, which are thinner, looser, and broader, than the bronchial vesicles.

This substance is dispersed through every part of the lungs, forms cellulous or spongy vaginæ, which surround the ramifications of the bronchia and blood-vessels, and is afterward spread over the outer surface of each lung, where it forms a kind of fine cellular coat, joined to the general covering of that viscus.

When we blow into this interlobular substance, the air compresses and flattens the lobuli; and when we blow into the bronchial vesicles, they presently swell; and if we continue to blow with force, the air passes insensibly into the interlobular substance. We owe this observation to M. Helvetius.

Vascular texture. All the bronchial cells are surrounded by a very fine reticular texture of the small extremities of arteries and veins which communicate every way with each other. The greatest part of this admirable structure is the discovery of the illustrious Malphigi.

Blood-vessels. The blood-vessels of the lungs are of two kinds;

one common, called *the pulmonary artery and veins*; the other proper, called *the bronchial arteries and veins.*

The pulmonary artery goes out from the right ventricle of the heart; and its trunk having run directly upward as high as the curvature of the aorta, is divided into two lateral branches; one going to the right hand, called *the right pulmonary artery*; the other to the left, termed *the left pulmonary artery*. The right artery passes under the curvature of the aorta, and is consequently longer than the left. They both run to the lungs, and are dispersed through their whole substance by ramifications nearly like those of the bronchia, and lying in the same directions.

The pulmonary veins having been distributed through the lungs in the same manner, go out on each side, by two great branches which open laterally into the reservoir or muscular bag of the right auricle.

The ramifications of these two kinds of vessels in the lungs, are surrounded every where by the cellular substance already mentioned, which likewise gives them a kind of vagina; and the rete mirabile of Malpighi, described above, is formed by the capillary extremities of these vessels. It must be observed, that the ramifications of the arteries are more numerous and larger than those of the veins, which in all other parts of the body exceed the arteries both in number and size.

Bronchial arteries and veins. Besides these capital blood vessels, there are others called the *bronchial arteries and veins*, which are very small, but they follow the bronchia through all their ramifications. They communicate with the pulmonary arteries and veins in many places; likewise with the arteries and veins of the œsophagus, and with branches of the coronary artery and vein. These are the nutrient vessels of the lungs.

Ligaments. Under the root of each lung, that is, under that part formed by the subordinate trunk of the pulmonary artery, by the trunks of the pulmonary veins, and by the trunk of the bronchia, there is a pretty broad membranous ligament, which ties the posterior edge of each lung to the lateral

parts of the vertebræ of the back, from that root all the way to the diaphragm.

Trachea arteria. The bronchia already described, are branches or ramifications of a large canal, partly cartilaginous, and partly membranous, called *trachea* or *aspera arteria.* It is situated anteriorly in the lower part of the neck, whence it runs down into the thorax between the two pleuræ, through the upper space left between the duplicature of the mediastinum, behind the thymus.

Having reached as low as the curvature of the aorta, it divides into two lateral parts, one toward the right hand, the other toward the left, which enter the lungs, and are distributed through them in the manner already said. These two branches are called *bronchia;* and that on the right side is shorter than that of the left, whereas the right pulmonary artery is the longest.

The trachea is made up of segments of circles of cartilaginous hoops, disposed in such a manner as to form a canal open on the back part, the cartilages not going quite round; but this opening is filled by a soft glandular membrane, which completes the circumference of the canal; but this cannot be to give way to the œsophagus: for, instead of descending immediately upon the middle of that canal, the trachea inclines a little to the right side, and the same structure is found in the back part of the great bronchial vessels, which are at some distance from the œsophagus.

Each circle is about the twelfth part of an inch in breadth, and about a quarter of that space in thickness. Their extremities are round; and they are situated horizontally above each other, small interstices being left between them, and the lower edge of the superior segments being turned toward the upper edge of those next below them.

They are all connected by a very strong elastic membranous ligament fixed to their edges.

The trachea is covered externally with a quantity of cellular substance, which unites it to the neighbouring parts, and it is lined on the inside by a particular membrane; which appears to be partly fleshy or muscular, and partly ligamentary, per-

formed by an infinite number of small holes more or less imperceptible, through which a mucilaginous fluid continually passes, to defend the inner surface of the trachea against the acrimony of the air which we breathe.

This fluid comes from small glandular bodies dispersed through the substance of the membrane, but especially from glands something larger than the former, which lie on the outer or posterior surface of that strong membrane by which the circumference of the canal is completed. The same structure is observable in the ramifications of the trachea from the greatest to the smallest.

All the vessels of which the lungs are chiefly composed, that is, the air-vessels or bronchia, and the blood-vessels, or the pulmonary and bronchial arteries and veins, accompany each other through this whole viscus.

They are disposed commonly in such a manner, even to the last ramifications, as that a subordinate trunk or branch of the bronchia lies between the like trunks or branches of the pulmonary artery and vein; the bronchial vessels being immediately joined to the bronchia. In some places these three kinds of vessels touch each other in such a manner as to leave a triangular space in the middle.

The bronchia are divided into a very great number of ramifications; and the last rami are the pedicles or footstalks of the small lobuli. All the lobuli are angular, oblong, broad, thin, &c. The footstalks send out other smaller membranous pedicles, which are very short, and terminate in the bronchial vesicles or cells, of which they are continuations. The subordinate trunks and rami detach a great number of these pedicles from their convex surface.

When we blow into the lungs, the bronchial cells nearest their outer surface appear like small portions of round vesicles; and from this appearance all the bronchial cells have got the name of *vesicles*, though they are all angular except those which I have now mentioned.

When we examine a lung without blowing it up, we find that the cartilaginous segments of the bronchia lie so near as to be

engaged in each other; and in drawing out any portion of the bronchia by the two ends, these segments are parted; and the whole canal is increased in length; but it contracts again, by means of its elastic membrane, as soon as that force is taken off.

When we open lengthwise any portion of the pulmonary artery and vein in the same lung, we meet with a great number of transverse rugæ, which are destroyed when these vessels are elongated. This is an observation made by M. Helvetius.

By virtue of this structure, all the ramifications both of the bronchia and pulmonary arteries and veins, have constantly the same direction, whether the lung be inflated or collapsed; and they contract in length, without being either contorted or folded. In exspiration these vessels are elongated, and shortened in inspiration.

These three vessels lie in a sort of cellular vagina, which accompanies all their ramifications; and is a continuation of their interlobular cells. The pelliculæ which compose it, are, however, there disposed in a more regular manner, and more longitudinally, than in other places, and thereby appear to form a true vagina.

When we blow through a pipe introduced so far as to touch immediately a trunk of the blood-vessels or bronchia, the air runs at first through all the cells that lie nearest that trunk or its branches; but if we continue to blow, it insinuates itself through the whole interlobular substance.

Bronchial glands. At the angle of the first ramification of the trachea arteria, we find on both the fore and back sides certain soft, roundish, glandular bodies, of a bluish or blackish colour, but reddish in a child; in size they vary from that of a field-bean to that of a millet-seed. Through these the lymphatic vessels of the lungs pass in their way to the thoracic duct.

The trachea has several coats, as has been already observed. The outermost or common covering surrounds that part of the trachea which lies in the thorax; but out of the thorax, this first coat is derived from the aponeurotic expansions of the mus-

cles of the neck; and it is between this and the following covering that the glands already mentioned are situated.

The second is a proper coat, being a continuation of the cellular covering of the lungs; the pelliculæ of which, nearest the cartilaginous segments, serve them for an external perichondrium. The third membrane lies on the inside, adhering closely to the same cartilages, and supplying to these the place of an internal perichondrium.

The fourth membrane is that which completes the circumference of the cartilaginous circles of the trachea. It consists chiefly of two laminæ or strata, partly muscular and partly tendinous; the external or posterior lamina being made up of longitudinal fibres; and the internal, or anterior, of transverse fibres. This membrane is perforated by the small ducts of the above-mentioned glands, which discharge a fluid when pressed; and being examined through a microscope, they appear vesicular or folliculous, much like that of the stomach.

The ligaments between the cartilaginous circles are very strong and elastic; and each of them is confined to two cartilages, without communicating with any of the rest; being fixed to the edges of these cartilages, much in the same manner as the intercostal muscles are inserted in the ribs.

As the bronchia penetrate into the substance of the lungs, they gradually lose their cartilages, till at last they become purely membranous; but the muscular lines of M. Mergagni appear as much, and sometimes more than before. The two planes above-mentioned continue likewise to be visible; and we observe very distinctly, sometimes even without a miseroscope, a great many small holes in the pellicles of the lobuli, and bronchial vesicles or cells which open from within outward.

Uses. Respiration is performed by organs of two kinds; one of which may be looked upon as active, the other as passive. The lungs are of the second kind, and the first comprehends chiefly the diaphragm and intercostal muscles.

As soon as the intercostal muscles begin to contract, the arches of the ribs are raised together with the sternum, and placed at a greater distance from each other; by which means

the cavity of the thorax is enlarged on the two lateral and anterior sides.

At the same instant the diaphragm is flatted or brought toward a plane by two motions, which are apparently contrary; that is, by the contraction of the diaphragm, and the dilatation of the ribs in which it is inserted. The external surface of the thorax being thus in a manner increased, and the cavity of the bronchia being at the same time, and by the same means, less resisted or pressed upon, the ambient air yields to the external pressure, and insinuates itself into all the places where the pressure is diminished; that is, into the aspera arteria, and into all the ramifications of the bronchia, all the way to the vesicles. This is what is called *inspiration*.

This motion of inspiration is instantaneous, and ceases in a moment by the relaxation of the intercostal muscles; the elastic ligaments and cartilages of the ribs bringing them back at the same time to their former situation. This motion by which the ribs are depressed and brought nearer to each other, is termed *exspiration*.

The pulmonary arteries and veins which accompany the bronchia through all their ramifications, and surround the vesicles, transmit the blood through their narrow capillary extremities, and thereby change or modify it, at least in three different manners.

The first change or modification which the blood undergoes in the lungs, is to have the cohesions of its parts broken. The second is, to be deprived of a certain quantity of serum, which transpires through the lungs, and is what we commonly call the *breath*. The third is, to be in a manner reanimated by the impression of vital air.

RESPIRATION.

The lungs completely fill the sacs formed by the pleura. They are freely suspended by the great blood-vessels; unless you call that a ligament, which is made by the external membrane of the pleura going to the lungs and to the basis of the diaphragm. Betwixt the lungs and pleura is found a watery or

rather serous vapour, of a coagulable nature, like that of the pericardium; which vapour transudes from the surface of the lungs continually in the fœtus, and not unfrequently in the adult.

The vesicles of the lungs do not receive the air by a single orifice from the windpipe, as a vial; but the air exhaling from the least branches of the windpipe, is admitted in such a manner into their irregular spaces, that it freely spreads through them from any one part of the lungs into all the rest, and returns again in like manner.

The air is driven into these vesicles through the windpipe, which arises from the larynx; and, in the upper part of the thorax is received between the laminæ of the posterior part of the mediastinum.

Its last branches are invisible, which exhale the air into the cellular spaces of adult lungs, and likewise receive the watery vapours exhaling from the arteries into the said spaces; whence they are thrown by exspiration.

The quantity of blood which enters into the lungs is exceedingly great, equal to (or even perhaps greater than) that which is sent in the same time throughout the rest of the body; which, therefore, alone, demonstrates some very considerable use proper to this viscus. And that this depends manifestly upon the air, appears from the universal consent of nature, in which we scarce find any animal without breathing; also from the structure of the lungs in the fœtus, in which, for want of air, they are useless, receiving only a small portion of the blood, which the pulmonary artery conducts from the heart. We next, therefore, to speak of respiration, by which the air is drawn into and expelled from the lungs.

It, therefore, now remains for us to inquire, why the air enters the lungs of an adult person; for with this they are in a manner constantly full, and of course are equally pressed, and resisting against the weight of the whole atmosphere: but that the lungs always contain air is evident; because, however close you compress them, they will be still lighter than water; and even in the fœtus, after they have been inflated but a few times,

they always swim; whereas they sink to the bottom of water, if they have not given admittance to the air.

The equilibrium of the air's pressure being removed in any place, it constantly descends or flows that way where it is least resisted. But air that is dense and heavy will descend more easily than such as is light, whose force scarce overcomes that of the air which is already in the lungs, nor is able by the same force to overcome the resistance of the bronchia, and the force by which the lungs compress the air contained in them. Hence an animal lives better in a dense than in a light air: although that kind of air is always most tolerable, which is pure at the same that it is light; such as that of the highest mountains of the Alps. Therefore, for the air to enter the lungs, they must make a less resistance to it than before; namely, the air, which is already in the cellular fabric of the lungs, must be rarefied: and this effect does follow, when the cavity of the thorax, in which the lungs are contained, and which they exactly fill, is dilated. Thus the air, which is always in the lungs, expands into a larger space; by which, being weakened in its spring, it makes a less resistance to the external air; and consequently a portion of the said external air descends into the lungs, sufficient to restore the confined and rarefied air, filling the lungs to the same density with that of the external air.

In orber to dilate the seat of the lungs, and thus to put the body in such a state that the external air may rush into the lungs, it is necessary for the thorax to be elevated. By this means all the sections of the thorax form right angles, and its capacity is increased. This motion is performed by various muscles, which either operate constantly or only at certain times. The intercostal muscles, therefore, all of them act perpetually in elevating the ribs.

By the action, therefore, of these muscles, the thorax is elevated, not altogether as one machine, nor would respiration be assisted by such a motion; but the ribs turning upon their articulations, though behind they are but little moved, yet the forepart of their extremities descends, and forms larger angles both with the sternum and vertebræ; but from thence in the middle of their arches, by ascending, their lower edges are

drawn upward. At the same time, the sternum is thrust forward more from the vertebræ and from the ribs. Thus the ribs are both removed farther from the vertebræ, and the right ribs depart from the left; and the diameter on both sides, betwixt the right and left ribs, betwixt the sternum and the vertebræ, is increased almost to two lines: and therefore this enlargement, following in every imaginable section of the thorax, will sufficiently dilate the cavity of the breast. This action of the ribs is more particularly complete in women, and in men who have no shortness of breath. These effects are produced least of all by the first ribs, but more by the following ones. In very strong inspiration, the ribs descend both behind and before; and, along with these, the sternum and the spaces between the cartilage are lessened. But this dilatation alone is not sufficient for healthy breathing: nor is it so conspicuous or evident, in men; although, in them, the intercostal muscles, by retaining and elevating the ribs, very much assist the inspiration in a tacit manner, while they afford a fixed point to the diaphragm, that the whole force of that muscle may be spent, not so much in depressing the ribs, as in urging down the abdomen. The greater part, therefore, of the space which the thorax gains in inspiration, arises from the action of the diaphragm; the centre of which is more moveable and at liberty than the rest; except in the middle of its tendinous part near the fleshy margin, where the incumbent heart makes a resistance; but the lateral parts and the fleshy portions belonging to them are the most moveable.

The structure of the parts, and the dissection of living animals, demonstrate, that the fleshy portions of the diaphragm, which on all sides ascend from the firm parts to the middle and more moveable, do, by their contraction, depress the same, and by that means draw downward the lateral bags of the thorax, which contain the lungs; and, by this means, the perpendicular diameter of the thorax is considerably increased. The fleshy parts are more depressed; the tendon less; both because it is fixed to the pericardium, and because its own substance does not contract. Even the œsophagus and vena cava are contracted, while the diaphragm exerts its action. So that the diaphragm almost alone performs the office of respiration in a

healthy man who is at rest; as also in that thorax whose ribs are fractured, or the sternum burst, or where the person will not make use of his ribs by reason of pain. The force of the diaphragm also, in dilating the breast, is greater, according to the calculations that have been made, than all the rest of the powers which contribute to respiration. A strong inspiration is as yet confined; because, during the greatest exertion of the diaphragm, the lowermost ribs are brought inward, and thus far the thorax is straitened. Lest this should always happen, the intercostal muscles interfere in ordinary inspirations; in very great ones they are inferior to the diaphragm, the phrenic nerve, which is more easily irritated than in most other muscles, forces the diaphragm to perform its office. The lungs themselves are altogether passive or obedient to the aetion of the air, ribs, and diaphragm; to which they are pressed into close contact on all sides, and when the thorax is denudated by the knife, leaving its capacity entire, the lungs appear through the pellucid pleura and diaphragm.

But in larger inspirations, which receive a greater quantity of blood driven into the lungs, and when there is any obstacle or difficulty opposed to the action of the lungs themselves; in those cases, several other powers conspire to elevate the thorax: which are muscles inserted either into the thorax, clavicles, or scapulæ; such as the scaleni, trapezii, cervicales descendentes, serrati superiores, and pectorales; together with the small elevators.

We have now surveyed the powers which are able to increase the capacity of the thorax in all its three dimensions. By these the cavity of the breast is dilated, so that it compresses the lungs less than before: the lungs then strive to diffuse themselves over that space, seeing they are never destitute of air, which expands itself by its elasticity as soon as the pressure is taken off. Without that muscular force the lungs have no proper power of their own by which they are capable of attracting air: and even when they are most full of air, by having the aspera arteria closed, the animal vehemently attempts to inspire, by the efforts of its intercostal muscles and diaphragm. It therefore remains, that the air, which is a heavy fluid, and pressed on all sides by the incumbent columns of the at-

mosphere, must now enter the thorax with the greater force the less air the lungs contain; or yet more powerfully, if they contain no air: but with no force at all, if the air admitted through a wound in the breast presses upon the surface of the lungs. In this action, therefore, which is called inspiration, the bronchia are every way increased, both in length and diameter; because all the diameters of the thorax are increased: but in this act, the inflated lungs always follow closely contiguous to the pleura without leaving any intermediate space. At the same time, the pulmonary blood-vessels, which are wrapped up, together with the bronchia, in a covering of the cellular substance, are likewise with them extended in length, and spread out from smaller into larger angles; by which means the circulation through them is rendered easier. While this is performing, the vesicular substance, or flesh of the lungs themselves, filled with air, increases those spaces through which the capillary blood-vessels of the lungs advance; whereby the vesicular pressure, upon each other, and upon those vessels adjacent, is lessened: thus, therefore, the blood will flow with greater ease and celerity into and through the larger and smaller vessels of the lungs. Hence a dying animal is revived by inflating its lungs, and facilitating the passage of the blood to the left ventricle of the heart; and thus people, seemingly dead by being kept a long time under water, are again recovered. But as for the pressure of the air upon the blood in the lungs in this action, it is so inconsiderable as not to deserve our notice, as being 300 times less than the force of the heart; nor can it ever urge the air into the blood, as it may be easily forced by art with a syringe.

There is, in the respiration of man and quadrupeds, no air admitted between the lungs and the thorax.

But respiration vitiates the air, by depriving it of its oxigene, and renders it unfit either for inflating the lungs or supporting flame; and lastly, it deprives it of its elasticity. Thus the air cannot keep the lungs distended, so as to transmit an increased quantity of blood through the dilated pulmonary arteries into the veins. Nor can the will dilate the breast beyond certain bounds, or assist that passage of the blood in an unlimited man-

ner. A state of body therefore will take place, in which the blood cannot pass through the lungs.

Thus is generated a new resistance to the blood continually coming from the heart: and in long retentions of the breath, as in making violent efforts, the venous blood, especially of the head, stagnates before the right ventricle of the heart which is shut, because it cannot evacuate itself into the lungs; and thus swells up the face with redness, sometimes, bursts the veins of the brain, neck, intestines, kidneys, and lastly of the lungs or the right auricle of the heart. A living person therefore, that he may remove the inconveniences which flow from an obstruction of the passage of the blood, slackens the powers of inspiration, and excites those of exspiration, which free the breast from an air too greatly rarefied.

These powers are, first, the elasticity of the ribs; which being drawn upward out of their natural situation, as soon as the powers which elevated them cease to act, spontaneously place themselves, so as to make more acute angles with the sternum and vertebræ. To this end conduces likewise the elastic force of the bronchia and vesicles distended with air, which strive to contract themselves. Hence exspiration is performed more easily and quickly than inspiration; and hence it is the last action of dying people.

To this also contribute the oblique muscles of the abdomen, together with the straight and tranverse ones. The former of these are, in one part of them, fastened to the lower ribs; and, in another part, they are attached to the os pubis and ilium, as a fixed point with respect to the breast. Therefore the straight muscles, being contracted, depress the arch or convexity, into which the abdominal viscera are thrust by the diaphragm, and bring the same nearer to a straight line: at the same time the abdominal viscera are pressed by those muscles upward and backward against the diaphragm, which alone is able to give way; and yield up into the thorax, which at that time is rendered shorter. The oblique muscles, for the same reasons, compress the lateral parts of the abdomen, and urge the liver and stomach backward, and press them toward that place where there is the least resistance. Lastly, they draw down the ribs

which were before elevated by the intercostals. The transverse muscles, indeed, do not draw the ribs; but they pull the cartilages of the false ribs a little inward, and render the whole capacity of the abdomen less, while at the same time they press the viscera against the diaphragm. Along with these we may reckon the powers of the sternocostal and long intercostal muscles, which are called *depressors*. By this joint force the superior ribs descend; but the middle ones more, the uppermost less, the lowest most of all; and the same are brought inward by their margin: the cartilages ascend, and return into acute angles with the sternum; and the sternum itself returns backward with the ribs. By these means the thorax, contrary to its former state, is every where rendered narrower and shorter, so as to expel as much air out of the lungs as is sufficient to relieve the uneasiness caused by its retention.

In more powerful respirations, when the inspirations are made greater, the exspirations are likewise increased by the assistance of some other powers, as of the sacrolumbalis, longissimus and quadratus muscles of the back and loins. This force, by which the air is blown out of the lungs, is sufficient to carry a leaden bullet, weighing about a dram, to the distance of 363 feet; which force is equal to a third part of the pressure of the atmosphere. But, in a healthy person, the muscles of the abdomen alone suffice to an easy exspiration, in which the lungs are not so much emptied of the air as they are by a violent efflation.

The effects of exspiration are, a compressure of the blood-vessels in the lungs, a reduction of the bronchia into more acute angles, a pressure of the reticular small vessels by the weight and contact of the adjacent larger vessels, and an expulsion of the renovated blood from the lungs; by which means part of the blood hesitating in the capillary arteries, is urged forward through the veins to the left side of the heart, while at the same time that part of the blood is resisted which flows in by the artery from the right ventricle. Exspiration, therefore, will stop the easy passage of the blood through the lungs; and when the whole thorax is compressed together, repels the ve-

nous blood into the veins of the head, and fills the brain and its sinuses.

In this manner a fresh necessity follows for repeating the respiration; because the collapsed vessels of the lungs resist the blood repeatedly expelled from the right ventricle of the heart. And this makes another cause of death in those animals which expire in vessels exhausted of air: for, in such, the lungs having the air drawn out from them, appear dense, solid, and heavier than water; whence they are rendered impervious to the blood. Of the same kind is the death of those who are killed by lightning, and perhaps by the noxious vapours of caverns. Thus, therefore, the organs of exspiration are relaxed so soon as that uneasiness is perceived, which arises from the hindrance of the blood's course through the lungs; and hence the powers of inspiration are excited into action, whereby the motion of the blood through the lungs is rendered free and quicker.

From what has been hitherto said, it appears, that respiration is unavoidably and absolutely necessary to life in a healthy adult person; because, whether the lungs remain long in a state either of exspiration or inspiration, we see death will be the consequence. Therefore no animal that has lungs like ourselves, after it has once breathed and received the air into the inmost parts of the lungs, and by that means brought a new and large quantity of blood to that viscus, can subsist longer than a few minutes without the use and benefit of a free air; but it will either perish, or at least fall into such a state as differs from death only in its being recoverable again by certain powers or actions. In an animal lately born, this necessity for air does not take place so suddenly.

OF THE ARTERIES IN GENERAL.

The arteries are long extended cylindrical tubes, whose diameters decrease as they divide into more numerous branches. In some places they seem to diverge or dilate; at least they become there of a large diameter, after they have been filled or distended with wax; which possibly may arise from some stop-

page of the wax, by whose impulse that part of the length of the artery becomes more distended than the rest. Examples of this kind we have in the basilar artery, at the basis of the skull, in the splenic artery, in the flexure of the carotid artery, according to Mr. Cowper's injections; in the humeral artery near its division; and, lastly, unless these experiments deceive us, in the spermatic arteries in all places, likewise, between the ramifications where the diameter of the artery is a little increased.

There is no external coat proper and perpetual to all the arteries; but the office of such a coat is supplied to some of them by one single external and incumbent integument, which in the thorax is the pleura, and in the abdomen the peritonæum. In the neck, arm, and thigh, a sort of thicker cellular substance surrounds the arteries. The membrane of the pericardium, which on all sides surrounds the aorta, returns back with the vessels to the heart. The dura mater imparts a capsule, that surrounds the carotid artery as it passes out through a hole in the skull. But the first true external membrane common to the arterial tube in all parts of the body, is the cellular substance, which in some parts (as in the thorax) we see replenished with fat.

This cellular coat is, in its external surface, of a more lax texture, painted with a great many small arteries and veins; and it has nerves running through its substance, which are none of the smallest. There is sometimes so much of this cellular substance about the artery, as might occasion one to think it hardly belonged to it as an external coat or lamella, but rather as some foreign net-work added to this vessel. Thus we find it in the arteries of the neck, groins, and subclavians; in the mesenteric, cæliac, and hepatic arteries; where it is chiefly interwoven with long fibres. And these are the vaginæ or capsules of the arteries, formerly observed by some eminent anatomists, and which, according to Wrisberg, are best seen in young animals.

As this cellular coat advances more inward, it becomes more dense, solid, and is tied more closely together by a kind of wool, and may be called the *proper coat* of the artery. That there is no tendinous coat of the arteries distinct from this last part of

the cellular substance, is evident from maceration, whereby the inner stratum of this arterious tunic changes into a cellular fabric, which may be divided into several layers.

Within the former, there is a *muscular coat*; the fibres composing which, are in general imperfect circles; that is to say, no fibre any where makes a complete circle round the vessel; but a number of segments conjoined together, with their extremities turned off sidewise, seem to form one ring round the artery. These fibres, in the larger arterial trunks, form many strata, appear of a reddish colour, and are remarkably firm and solid; but in the smaller arteries they are by degrees more difficult to demonstrate, and seem to be wanting in the arteries of small animals. Dr. Haller has never observed them to run along the vessel lengthwise. Under these membranes, but pretty difficult to demonstrate, is an exceeding short cellular texture, into which a chalky concreting matter is poured when an artery ossifies.

The *innermost coat* of the artery is thin, and fine polished by the influent blood; so as to form a single incrustation that every where lines the fleshy fibres, which are not very continuous one to the other, and prevents the blood from insinuating into the spaces betwixt them. It is every where smooth and without valves; although, from a sort of mechanical necessity, sometimes certain folds, raised into a semicircle at the origination of branches, form a projecting eminence; as we see at the branches produced by the arch of the aorta. Yet, in arteries of the viscera, the innermost coat is softer, lax, wrinkled, and almost friable, especially in the ductus arteriosus.

The arteries themselves have *arteries* which are more particularly spread through their external cellular coat; and, springing on all sides from the next adjacent small arterial trunks, form numerous branchy net-works, which are all of them indeed very minute, but plainly appear, even in the fœtus, without injection, to be very numerous. There are also *nerves* which descend for a long way together through the surface of the artery, and at last vanish in the cellular substance of the vessel; of which we have a specimen in the external and in-

ternal carotids and arch of the aorta; and Dr. Walter has shown them in numerous arteries in the thorax and abdomen.

The *sections*, or divisions, of arteries show themselves with a round cavity, because they are elastic; and this is the reason why, from the small arteries of the teeth, hemorrhagies are sometimes fatal. The aorta, indeed, of the thorax and abdomen, the carotids of the neck, and some other arteries of the dead body, from their lessened extension, appear somewhat flat or depressed : but their round figure, or circular section, is every where restored by injection. *Their elasticity* is also evident in that powerful compressure, which a segment of a large artery makes upon the finger that distends it, and which is much stronger in a dead than in a living body, indeed, this force yields to that of the heart; but instantly recovers itself when the heart is relaxed, and restores the artery to its former diameter ; and this makes the *pulse*, which all arteries possess, although the systole and disastole can be perceived by the finger, only in the larger, not in the smaller ones naturally ; and in the ultimate inflection of the arteries, the pulse totally vanishes ; but, by an increased motion of the blood, even the lesser arteries make a violent pulsation, as we see in an inflammation, or in pressure depending on an internal cause. These vessels strongly contract lengthwise, and are rendered shorter on dissection.

The *strength* of the arteries is considerable enough : but as the dense hard net-work of the outer cellular coat refuses to yield to a distending force, it breaks without much difficulty, almost easier than the coats of the veins ; and thence arise aneurisms. But, in general, the trunks are, in all parts of the body, weaker, and the branches stronger, in their coats ; whence the impulse of the blood may exert a considerable effect upon the former, but least of all on those of the limbs. Hence it is, that aneurisms are most frequently formed near the heart ; for, in the lower extremities, the strength of the arteries, and of the veins too, is much increased, as well as in the secreting organs.

With regard to the course and general distribution of the arteries, nature has every where dispersed them through the

whole animal body, except in a few membranes. But she hath disposed of the trunks every where in places of safety; because wounds cannot happen to the smaller of them without danger, nor to the larger without loss of life. The skin is spread with numerous short and small arterial trunks; but the larger ones, defended by the skin and muscles, creep along near the bones. In general, the arteries are in proportion to the parts of the body to which they are sent. The largest go to the secretory organs, to the brain, and to the spleen; the lesser ones to the muscular parts.

The proportion of the cavity of the artery to its solid part is is not every where the same, nor is it constant even in the same artery. This proportion, in the first place, is least of all at the heart, and increases at the arteries remove farther from it. Secondly, in a full-fed plethoric animal, whose blood passes freely, and with great force through its arteries, the proportion of the solid parts of these vessels is less than in a famished extenuated creature, whose blood hath a feeble motion.

From the trunks of all the arteries branches are sent forth, and from these again proceed lesser twigs by a numerous division, of which you can scarce find the end, though you may perhaps count twenty subdivisions of this kind. Here the sections of any two branches taken together, always exceed that of the trunk whence they come, in the proportion of three to two, or somewhat less. Also every trunk just above its division is somewhat broader or more expanded. The angles, at which the branches go out from their trunks, are generally acute, either half right angles, or nearly so; to the forming of which angles, as we see in mechanics, there is required the longest projection. Instances of their going off at right angles, or nearly so, we have in the lumbal or intercostal arteries; of their going off in a retrograde or reflected course, we have one instance in the coronaries of the heart, and another instance in the spinal arteries, which are produced by the vertebrals. But, generally speaking, those which are esteemed retrograde or reflexed, were sent off at their origin, in acute angles; such as the ascending artery of the pharynx, the descending one of the palate, the umbilical

mammary arteries, and the nutritious ones of the large bones. Lastly, we often observe large branches arising under lesser angles, and smaller ones under greater angles: but it is rare that we observe two arteries of a large diameter run together into one trunk. An example of this, however, we have in that artery which is formed out of the vertebrals: in the smaller ones it is frequent, as in both the spinal arteries, and that of the sincipital foramen. In many parts, the arteries have repeated alternate undulations or flexures, as they run on in a spiral course, wherein we see their diameter often considerably enlarged, as in the large intestines, womb, face, spleen, lips, and iris. Even the straight arteries in other places, if too much distended, fall into serpentine flexures. Sometimes they are suddenly twisted into a kind of circles, as the carotids under the mamillary process.

The arteries are frequently conjoined by intermediate branches, in such a manner, that the twig of some certain artery shall run to meet one of the same kind from another neighbouring artery, and, by joining together with that, form one trunk. Instances of this kind we have among the large trunks in the intestines, among the middling ones in the kidneys, womb, &c. and among the smaller in all parts of the body; insomuch that there is no part of the human body, wherein the neighbouring arterial trunks, whether of the same or of different denominations, do not form anastomoses or joinings one to the other by intermediate branches. Of rings diverging laterally from the arteries, and returning into themselves, we have instances in the eye and brain. The extremities of the arteries, which are either cylindrical or nearly so, send off smaller branches, which, for their extent, are more numerous and generally disposed like a net; so that each branch, by its smaller twigs, forms anastomoses with those of its neighbouring branches: and thus we find it in all membranes. By this means it happens, that, though the passage from the heart to any part of an artery is obstructed, the blood may nevertheless flow through the neighbouring arteries into all the branches of the obstructed one.

Lastly, one of the least arteries is either changed by a continuation of its canal into a vein, in such a manner, that the ultimate little artery, which is generally reflected, having surpassed

the angle of its reflection, becomes now a small vein; or else a branch, sent out at right angles from the artery, is inserted under a like angle into the branch of a small vein. Both these kinds of mechanism are demonstrated to us by the microscope, and the easy return of injections through the veins into the arteries. And these vascules we see sometimes large enough to receive only one, and sometimes several globules at a time. A large artery is never observed to open into a vein.

In the viscera, we find the small arteries disposed not so much in net-works as in a different fabricature, wherein the small branches descend very thick, or in clusters, parallel to the trunk, so as to resemble pencils, or threads, according to the various disposition of the parts.

Sometimes the arteries end in another manner, namely, by being converted into vessels of the smaller kinds. These are sometimes continuous to the arteries and real arterial trunks, as may be observed in the ophthalmic artery, upon tracing the arteries of the tunica choroides, or the colourless ones of the circle of the uvea and iris. That a net-work of pellucid arteries is continuous with the red branches of the ophthalmic one, is evident from inflammations, and the redness of the parts when relaxed by vapour or by cupping; from repletion, and the microscopical experiments of Lieburkuhn upon frogs, in which colourless globules were seen to pass from a red artery into a lateral vessel. In a fabric of this kind the red blood is easily forced into the smaller vessels.

In other places the smaller vessels seem to proceed laterally as branches from the trunks of the least sanguineous arteries, and are drawn out into trunks still smaller. These are called *excretory ducts*. It is with difficulty that these vessels are filled with red blood; of this, however, we have examples in the kidnies, the liver, and breasts. Indeed the blood, when vitiated, penetrates the excretory ducts of the whole body, even without hurting the vessels; nor is that aberation found to be productive of any evil consequence.

Another termination of the arterial extremities is into the exhaling vessels; and this is a manner of their ending very frequently to be observed in all parts of the body. The whole skin,

all membranes of the human body, which form any close cavity, all the ventricles of the brain, the anterior and posterior chambers of the eyes, all the adipose cells and pulmonary vesicles, the whole cavity of the stomach and intestinal tube, through which the air has a passage, are all of them replenished with exhaling arteries of this kind. These emit a thin, watery, gelatinous humour, which, being collected together by standing, sometimes makes no inconsiderable quantity; and, particularly by disease or death, is converted into a watery, but coagulable lymph. The truth of this is easily demonstrable from the watery sweat that ensues after injecting the arteries. In some places, indeed, they exhale not a thin vapour, but blood itself, as we see in the heart, the cellular fabric of the penis, urethra, clitoris, and nipple of the female breast; in all which the blood itself is naturally poured out. Does not every secretion, that is made in true glands or hollow cryptæ, bear some analogy to this exhaling fabric?

OF THE COMMON OFFICES OF THE ARTERIES.

The blood is driven from the left ventricle of the heart into the aorta; and here the mass of this purple fluid strikes first against the right side, and is then reflected to the left side of the aorta; whence flowing in a vortical or whirling motion as much as that full vessel will permit, it goes on through the arteries, with an alternate collision against, and repercussion from, their sides.

The arteries are, in a living person, always full of blood; since the jet or stream which starts from an artery, is not interrupted by alternate stops, while the heart rests or relaxes itself, but it flows on in a continued thread: add to this, that the microscope shows the arteries, in living animals, to be full, both in their systole and diastole; nor can the circular fibres of the arteries so far contract themselves as entirely to evacuate these tubes. Since, therefore, a new wave or column of blood is sent into the arteries, already full, although it bear a small pro-

portion to the whole mass contained in the arterial system throughout the body, hardly ever exceeding two ounces; yet, by its immediate contact with the precedent wave or column, which moves slower as it gets farther from the heart, it consequently drives the same forward, lengthens the artery, and makes it assume a cylindric form, augments its diameter, presses the membranes closer to one another, urges the convex parts of the arterial flexures outward, and causes their spiral waves to be more serpentine, as injections demonstrate to us. This dilatation of the artery, whereby its capacity is changed from a less to a greater circle, is called the *pulse*; the diastole of which is an expansion of the artery beyond its natural diameter. This being the proper or characteristic action of life, results from the heart only, and is in nowise natural to the arteries left to themselves. Hence when the motion of the heart is intercepted, whether by aneurism, ligature, or otherwise, there is no pulsation of the arteries to be felt; and hence there is a sudden cessation of the pulse, by a wound through the heart, in a living animal. But the artery is proportionally more dilated, as the wave of blood flows on before more slowly, and the more the velocity of the new wave exceeds that of the former one.

The systole or contraction of the artery follows the dilatation of it. For the heart having emptied itself, and removed the stimulus of the blood, comes into a state of relaxation and rest. But the artery, at this same time, by its innate elasticity and contractile power residing in its circular fibres, irritated likewise by the stimulus of the blood, contracts itself, and expels as much blood as served to dilate it beyond its mean or middle diameter: this quantity of blood is either forced into the smaller and scarce beating arteriolæ, or into the veins, as the semilunar valves of the aorta oppose the return of the blood in the part of that vessel through which it has just now passed. So soon as the artery has freed itself from this wave or column of blood, being no longer stimulated by distention, it directly collapses by its own proper contractile force, and is now again ready to yield to a new wave or column of blood sent into it from the heart: whence follows a repeated diastole.

That the arteries thus contract, and, by that force, prope

their contained blood, is proved evidently from their strongly contractile nature; from the apparent diminution of the diameter or dilatation they receive from the heart; from the evacuation that follows, by the proper force of the artery itself, driving out all the blood that is contained in the lateral branches betwixt two ligatures; from the return of the blood to the heart through veins whose artery is tied, which therefore the heart has no share in propelling; from the wave of blood being greatest when the heart is in its diastole, as observed by some eminent anatomists; from the strength with which the blood is ejected from the tied aorta below the ligature; from the evacuation which the arteries make of their contained blood even after death into the veins, whereby these latter appear much fuller than the arteries; and, lastly, from the considerable saltus of blood that issues from a large artery in an animal even after death, mounting to the height of two feet: to which add, the convulsive contractions of the animal in which the artery is thus wounded, and the remarkable closings of the mouths of divided arteries in wounds, and a sphacelation of the limbs from an ossification of the artery; whence the veins become distended.

The mean swiftness of the blood's motion being diminished in the time of the heart's systole, but increased during its diastole, is such as carries it through a space somewhat less than one foot in the space of a second of time; and the constant plenitude of the arteries renders it impossible for us to perceive any succession in the pulses of different arteries; whence all the arteries of the body seem to beat at one and the same instant, whilst the heart strikes against the breast; and yet there is certainly a succession in the systole of the arteries, by which the aorta seems to contract in the same order successively, as it is filled by the blood expelled from the heart; so that the part of the artery next the heart is first constringed, and thence gradually, the arterial contracting force proceeds to the extremities. An instance of this we have in the intestines; and the same is evident to the eye in insects, who have a long fistulous and knotted heart, manifestly contracting in a succession from the beginning to the end. But the mind cannot distinguish the

least points of time, which are the measures of this succession, and amount only to a few thirds of a second.

If it be asked, Where this pulsation ends? we answer, In the least arteries, and cylindrical originations of the veins. We have already mentioned the velocity with which the blood comes from the heart. But that velocity continually decreases. Certain we are, (1.) That the sections of the arteries, composed by the aggregation or sum of their transverse sections, as they divide farther in their course from the heart, greatly exceed that of the aorta; so that since the ratio, or less proportion of the trunks to their branches, continually diminishes as they make less ramifications, and this in a variable or uncertain proportion; the difference of that ratio or proportion will be the greatest betwixt the section of the aorta at the heart, and the sum of the sections of all the small arteries, where they are least, in the extreme parts of the body. Again, (2.) The proportion of the arterial membranes or coats in thickness, with respect to their capacities, is greater as the arteries grow less; and is largest in the least of them, which transmit only one globule at a time. The truth of this is proved from anatomy, and the forcing of air into the arteries, by which they burst always more difficultly as they are less; and from the calculation itself, by which the magnitude of the least arteries is determined from the globules distending their two semicylindric membranes. Add to this, (3.) The friction of the juices through the least vessels, inflected and meeting together in angles; which friction, even in the most fluid water, running through long pipes that are single, and in a direct course, greatly diminishes the velocity, and more in proportion as the tube is of a less bore; while again, as the artery is less, there are a great number of globules rubbing and grating against its membranous converging sides. But moreover, (4.) The inflections and folds, or plates of the vessels, greatly slacken the blood's motion; since always some part of the impelling force is spent and lost in removing the convex parts of the folds, and changing the figure of the inflected vessel. The angles likewise take off more from this force in proportion to their acuteness, or the more they recede from a straight line. Lastly, (5.) A considerable allowance must be made for the great viscidity o

tenacity of the blood itself; since, by rest only, it directly hardens into clots; and since it is from the circulatory motion only of the blood, that this mutual attraction of parts is overcome, so as to hinder it from adhering to the sides of the arteries. From all which considerations, you will observe, that the blood meets with the greatest retardation in its course in the least vessels. And the opposition it meets with in the branches lessens the velocity of the blood also in the trunk: the opposition of torrents of blood to one another in the anastomoses of vessels also destroys some parts of its motion. We may easily perceive the amounts of this retardation will be very considerable, although it be difficult to estimate it justly. In the larger trunks the blood of a living animal flows with the rapidity of a torrent: but, in the least branches, it creeps along very slowly; so that in these it begins to put on a state of coagulation. It is also well known to surgeons, that a small branch of an artery near the heart or aorta bleeds more dangerously than a much larger one that lies at a greater distance. The weight of the incumbent atmosphere, of the muscles and fleshy parts lying above the artery, and the contractile power of the vessel itself, make a resistance indeed to the heart; but do not lessen the velocity of the blood, seeing they add as much in the diastole as they diminish in the systole.

It is certain, however, from incisions made in living animals, that the single globules of blood, which move separately in the small vessels, do not lose so much of their velocity as, by calculation, they ought to do. We must therefore assign some causes by which this power, destructive of the blood's motion is lessened. And, in the first place, it is certain, that the lights of the branches do not bear such a proportion to the trunk in the smallest vessels; their great smoothness diminishes the friction. The facility likewise with which the blood flows through the veins, expedites its passage through the little arteries, which immediately communicate with these veins.

The pulse therefore ensues, because the anterior wave or column of blood moves on slower, while the subsequent or posterior wave comes faster; so that the preceding is an obstacle to

the consequent blood. But since the force of the heart weakens as the blood goes on, and the contractile power of the arteries increases, therefore the disproportion of celerity betwixt the antecedent and consequent waves or columns of blood coming from the heart, will be continually lessening with respect to the blood that is urged on by the contraction of the smaller vessels, till arriving at a part where there is no excess or difference, it will there cease to make any pulsation of the artery; because here the anterior and consequent blood flow evenly, or with the same celerity. But this place of equality in motion cannot be in the larger and more conspicuous arterial branches: for in them the wave, last coming from the heart, moves quicker than what went before; as is evident from the inflammatory pulsation of them, especially in the small arteries of the eye. But, in the least red arteries, the pulse at length begins to vanish. This is evident from the equable motion of the blood, often seen by a microscope through the arteries of a frog. In the larger vessels, however, such as may be about the sixth part of a line in diameter, the pulse is perceptible. But in the least veins visible to the eye, there is no sensible pulsation or accelerated motion of the blood, whilst the heart contracts, demonstrable either by the microscope or any other experiment.

Even in the veins, the blood presses against their sides, as appears from the furrows hollowed out of the bones, and the swelling of the veins on being tied. If it be asked, Why the veins do not beat? (for we do not allow that to be a pulse which happens from respiration, from the rejection of the blood from the right auricle, or from the muscular part of the vena cava): the reason of this seems to be, that the blood, immediately on its leaving the heart, is more retarded in its motion than when it passes into the smallest vessels. Hence, the short space of time by which the velocity of the last wave exceeds the foregoing, is greatest at the heart, and grows gradually less, till it at last totally vanishes.

The pulse is therefore the measure of the powers which the heart spends on the blood; because it is the immediate and full effect of those powers.

Through the least veins the blood moves on very slowly,

partly by force of the heart, and partly by the contractile force of the arteries. The first is proved by a renewal of the motion of the blood in persons drowned; where, merely by exciting the action of the heart, the whole mass is again propelled. But the contractile force of the artery is proved by what has been said above. But after death the blood continues to move, in part, also by its own gravity, and by the elasticity of the air generated or extricated by putrefaction.

But the blood moves on faster in the larger veins. For whenever the impelling powers remain sufficient, and the conveying small vessels are rendered narrower, the motion of their contained fluids must of course be accelerated; since the section of the venal trunk is much less than that of all its branches, in the same manner as that of an artery is less than the sum of the branches into which it divides. Therefore if the motion of the venal blood loses nothing in its way, the proportion of its celerity in the vena cava, to its celerity in the veins of the thirtieth division, will be thirty times greater in the former, in proportion as the conjunct sections of all the small veins exceed the section of the cava. In like manner, too, the friction or attrition of the blood in the veins, and its contact with their sides, diminish.

But since the blood moves thus slowly in the least arterial vessels and incipient veins, and as the weight of the blood itself in many places wonderfully hinders its return to the heart, while, at the same time, the very thin coats of the veins have but little contractile power to be expected from them; therefore nature has used various precautions, lest, from the slowness of its motion, it should any where stagnate or concrete. To obviate this, she has supplied the veins with more watery vapours and fluxile lymph, than she probably sent by the arteries, if we consider the great exhalation that is made from the arterial blood in the lungs.

She has, therefore, likewise placed the veins near the muscles, that by the turgescence or contractions of the latter the veins may be pressed; and since any pressure upon the veins must be determined toward the heart, therefore all this force

must be entirely employed in accelerating the return of the blood to the heart. Hence proceeds that wonderful quickness of the pulse, heat, and redness of the body, with a short and laborious breathing, that attend muscular motions or violent exercises.

Moreover, those muscles which constantly urge or press violently the contiguous viscera on all sides that are contained in any of the common cavities, do all of them powerfully promote the return of the venal blood to the heart. Such an effect has the conjunct pressure of the diaphragm with the abdominal muscles, in respect to the abdomen. Lastly, the pulsations of the arteries, which run every where contiguous and parallel to the sides of the veins, have no inconsiderable effect in promoting the return of the venal blood; since, as we have before shown, any impulse acting on the veins can determine their blood to the heart only.

To these is added a force not yet sufficiently known, by which the blood is brought from a place where it is more compressed to one more lax, and where it meets with less resistance. In this matter also respiration is of great efficacy; in which the motion of the blood into the lungs, when relaxed, is accelerated by the power of derivation from all parts of the body: and again, in exspiration, it is driven into the trunks of the veins in the head and abdomen. Hence the swelling of the veins, and likewise of the brain, in the time of exspiration. The circulation is not indeed assisted by these causes, but the blood is agitated and pressed. The anastomoses of the arteries contribute to the same end; for they render the passage of the blood more easy from those places where it is obstructed to such as are more free.

By these means, the blood in a healthy person, using sufficient exercise of body, moves on with such a velocity, as suffices to deliver as much of the purple fluid in every pulse by the vena cava to the heart, as is equal to what is sent out by that great artery the aorta. But rest or inactivity of body, and a weakness of the contracting fibres of the heart and other muscles, frequently render this motion of the venal blood more difficult.

The time in which an ounce of blood, sent out from the left ventricle of the heart, returns to the right, and which is com-

monly reckoned the time in which the greater circulation is performed, is uncertain, and different in every different portion of the body. However, the ounce of blood propelled in that quantity, which we have mentioned, the amount of it will be about 7 one-half ounces in an hour with 4500 pulses; and the amount of the perfect circulations will be about 23 one-half.

OF PARTICULAR ARTERIES.

THE AORTA.

The large artery, termed AORTA, opens with a wide orifice from the superior and posterior side of the left ventricle of the heart. Its roots seem incorporated with the very substance of the heart; as it is not only intimately united with its internal surface, but some muscular striæ of the ventricle are also mixed with the white line, which is called *Tendo Arteriosus*, and which indicates the commencement of the artery. Some transverse fibres of the heart are united to the external part of the aorta, and cover it for a line and an half. Having left the heart, the aorta is immediately expanded; nor does it again recover its diameter till it sends off the subclavian artery of the right side.

In its ascent, it is first inflected to the right, behind and beyond the pulmonary artery; it then gradually inclines itself to the left, till,

having formed a transverse arch, it is seen projecting behind the lungs, at the left side of the vertebræ. Supported by these, it descends in the same straight line with themselves; till having, at last, entered the abdomen, it again begins to turn toward the right, and rests upon the middle of the vertebræ.

By the arch of the aorta, is meant its parabolic flexure, the right pillar of which first stretches to the right, and then to the left, while the left advances almost in a straight line.

In considering the whole extent of the arch, we observe that it springs from the ventricle at the inferior margin of the third rib, ascends by an oblique and winding course to the lower margin of the first; its exterior and right extremity corresponding to the middle of the cartilages of the ribs; and its left extremity, being concealed by the left lobe of the lungs, proceeding onward, and, in like manner, corresponding to the vertebral extremity of the ribs.

FIRST SUBDIVISION.

BRANCHES FROM THE ARCH OF THE AORTA.

I. THE two CORONARY ARTERIES of the Heart, viz. the Right or Inferior and Left or Superior, which being sent off above the interior and posterior semilunar valves, form, in returning to the heart, an acute angle with the rising trunk. II. The INNOMINATA. III. The LEFT COMMON CAROTID. IV. The LEFT SUBCLAVIAN.

The three last arise as distinct branches from the greatest convexity of the arch. The first of them passes obliquely upward, and to the right, over the Trachea; and having advanced about two inches, divides at its right extremity into the RIGHT COMMON CAROTID, and the RIGHT SUBCLAVIAN. The other two branch out from the Aorta near to the former, and are also similar to them.

I. The RIGHT CORONARY—is larger than the Left. Covered by fat, it runs between the auricle and ventricle to the flat surface and apex of the heart, inosculating freely with the left coronary, both by its branches and the extremity of its trunk.

These branches are,

a. One running on the right to the aorta, and on the left to the pulmonary artery.

b. A number going to both sides of the right auricle—to the two venæ cavæ—behind to the sinus—to the aorta—and to the pulmonary veins.

c. Five branches winding on the convex surface of the heart; the longest of which unites with the left coronary branches beyond the septum, near the apex.

d. Branches passing over the plain surface and right ventricle, as far as the apex of the heart.

II. The Left Coronary—after going out between the pulmonary artery and the left auricle, divides into two branches—

a. An Anterior Branch, running tortuously upon the convex surface of the heart, in the direction of the septum, to the apex, where it is reflected on the posterior surface of the heart. This gives,

1. Branches, to the trunks of the arteries, uniting with those of the right coronary.
2. Numerous branches to the left ventricle.

b. A Circumflex Posterior Branch, which, winding between the left sinus and the ventricle to the rounded extremity of the heart, terminates toward the apex, upon the flat surface. It gives

1. Branches running upwards and extensively ramified on the left sinus and auricle, and proceeding at last to the inferior cava.
2. Branches, losing themselves in the left ventricle.

N. B. The coronary arteries, wherever they approach the branches of the phrenic, internal mammary, and bronchial arteries, communicate with them by frequent inosculations.

III. The Right Subclavian.—For the description of this and the Left one, see below.

IV. The Common Carotid—has on each side a similar distribution of its branches, though the Right be a little larger than the Left. It lies on the anterior surface of the vertebræ, and is united by cellular membrane to the intercostal nerve—the par vagum beneath, and the internal jugular vein above. It thus ascends one continued trunk parallel to the Trachea, as high as the superior margin of the thyroid cartilage. It there divides into branches of equal size; the anterior of which is called the *external carotid*; and the posterior the *internal* or *cerebral*.

DISTRIBUTION OF THE COMMON CAROTID.

(I.) The External or Superficial Carotid. This artery has scarcely arisen, when it advance forward, and divides into eight branches variously distributed.

A. The superior thyroid, issuing near the origin of the trunk, and descending windingly to the superior margin of the thyroid gland, gives off.

a. The Superficial Ascending Branch, running above or below the os hyoïdes, and there forming an

arch with the branch from the opposite side. This again divides into,

1. Branches going to the hyo-thyroideus, sterno and omo hyoidei muscles, the platysma myoideus, and skin.

2. Branches to the ligament, which unites the thyroid cartilage to the os hyoides.

b. The Superficial Descending Branch, running downwards, and dividing into several branches, with various communications. These are distributed to,

1. The sterno mastoid, platysma-myoideus, the thyroid cartilage, the hyo and crico thyroidei muscles, and the middle and lowest constrictor muscles of the pharynx. Some of these occasionally come off from the superior ascending branch.

2. Branch uniting, uniting with its fellow of the opposite side above the cricothyroideus, and there forming a ring.

c. The Laryngeal Branch.—Larger, and often proceeding from the superficial ascending branch. It hides itself, with the recurrent nerve, between the cricoid and the thyroid cartilages; or penetrates the membranous interstice between the thyroid cartilage and the os hyoides; or even sometimes runs to the interior part of the larynx, through a passage peculiar to itself in the thyroid cartilage, and at last sends off,

1. An ascending branch---going to the upper margin of the epiglottis and its membranes.

2. Transverse branch---given to the posterior arytenoid and cricoarytenoid muscles.

3. Descending branch---running to the thyroarytenoid---the lateral and posterior cricoarytenoid---the lateral ligament---and the ligamentous expansion spreading outward.

A small trunk at last goes out, and loses itself in the cricothyroideus.

d. The Thyroid Branch—inosculating in the substance of the gland itself with the thyroid branch

of the inferior thyroid artery, and with its fellow of the opposite side.

B. The LINGUAL, or SUBLINGUAL ARTERY, winding above the os hyoides, forward, upwards, and inwards, to the tongue. At its commencement, it either passes over, or is covered by the hyoglossus; then is concealed by the genioglossus. At the anterior margin of the hyoglossus, it is subdivided into *e* and *f*. It gives off,

a. Branches to the middle constrictors of the pharynx.

b. The Hyoidal Branch—often uniting at the superior, but sometimes the inferior, margin of the os hyoides, with the opposite branch, and distributing twigs to the contiguous muscles of the os hyoides and tongue.

c. Branches to the mylohyoideus, genio, sterno, and coraco-hyoidei, and to the digastric.

d. The Dorsal of the Tongue—running outward and upward, near the insertion of the styloglossus. Having reached the dorsum of the tongue and the epiglottis, it forms a plexus with the branch of the opposite side, and is ramified upon the adjoining part of the pharynx.

e. The *Sublingual*—the superficial branch of the divided trunk, rising to the symphysis, between the sublingual glands and the geniohyoideus, often penetrating the mylohyoideus, and losing itself in the integuments of the chin. If larger, it often supplies the place of the submental artery. In this course it sends off many irregularly disposed branches; of which the most remarkable are—1. Branches to the sublingual gland. 2. Branches to the geniohyoideus, mylohyoideus, the digastric, and skin. 3. Branches to the inferior lip.

f. *Ranina*—a large and important branch, leaving the trunk at an obtuse angle. It runs tortuously between the fibres of the genioglossus to the surface and tip of the tongue, passing along the middle of each side of its inferior surface.

C. The EXTERNAL MAXILLARY, LABIAL, ANGULAR, OR FACIAL.—Concealed at its origin by the stylohyoideus, and the tendon of the digastric. Ascends, in a tortuously, forward, through the depression of the sub-maxillary gland, and, winding over the maxilla, follows the anterior margin of the masseter;—afterward branches out, under the zygomatic muscles, in serpentine windings, upon the face and the sides of the mouth, and of the nose. Its numerous branches are divided into two classes: the first, comprehending those arteries that leave the trunk before it reaches the maxilla, from *a* to *f*; the second, the branches distributed on the face itself, from *g* to *m*.

a. The Ascending Palatine—covered by the styloid muscles—lies upon the sides of the pharynx, near the external margin of the internal pterygoid muscle. Twigs being sent from it to these muscles, to the tongue, the tonsils, and the Eustachian tube, it is divided, near the side of the levator palati, into

1. Superficial Palatine Branch, following the course of the circumflex muscle of the palate, and supplying the pendulous velum and its glands.
2. Deep Palatine Branch, perforating the velum under the levator palati, and supplying the uvula, palate bone, tonsils, and tendinous expansion of the circumflex.

b. Minuter branches to the stylohyoideus, the stylopharyngeus, the hyoglossus, and glands.

c. The Tonsillar Branch—sometimes wanting—near the insertion of the styloglossus penetrates the lateral parts of the pharynx to the tonsils, and expends itself in numerous small branches, spreading on their surface, and reaching the tongue.

d. A cluster of twigs supplying the maxillary glands. Some of them running to the pterygoideus, the tongue, the integuments of the neck, the chin itself, and even to the masseter.

e. The Pterygoid Branch distributed to the internal pterygoid, the mylohyoideus, the superior constrictors, the constrictors of the isthmus of the fauces, and sometimes to the tongue.

f. The Submental Branch—goes out near the bend of the trunk over the maxilla, between the anterior part of the digastric, the mylohyoides, and the margin of the maxilla, almost to the symphysis of the chin, where it divides into 2 and 3. When it supplies the place of the sublingual, it distributes a great abundance of twigs; and commonly

1. Number of branches, variously ramified on the maxillary glands, the skin, the mylohyoideus, and the mouth.
2. Superficial Branch---ramified on the depressor of the inferior lip, and the skin.
3. Deep Branch---covered by the depressor; distributed to the levator menti, the depressor of the angle of the mouth, the orbicularis, and skin, and inosculating with the branches of the inferior labial.

g. The Masseteric Branch—Uniting with a branch of the temporal artery of the same name upon the surface of the massiter.

h. The Inferior Labial, or Superficial Branch—rises often double, goes forward, and, having sent branches to the buccinator, the depressors of the angle of the mouth and lips, and the orbicularis, unites with the inferior labial of the opposite side, with the inferior coronary, and the inferior max-

illary; then passing under the depressor of the angle of the mouth to the inferior lip, it divides into two, and sometimes produces the inferior coronary of the lip.

i. Many branches, spreading above the buccinator, and anastomosing with the transverse of the face, the buccal, and the alveolar.

k. The Coronary of the inferior Lip—arises near the angle of the mouth, and, covered by the depressor of the angle and the orbicular, proceeds in a winding and transverse direction, upon the membrane of the mouth, to its fellow of the opposite side, with which it inosculates. From this are distributed,

1. Branches to the masseter, the parotid gland, Steno's duct, the buccinator, and the orbicular.
2. Branches descending to the depressor lubii inferioris and skin, and inosculating with the neighbouring arteries.

l. The Coronary of the Superior Lip—like the preceding, but larger and more tortuous, it passes under the great azygomatic and the orbicular muscles, runs along the margin of the superior lip, and gives

1. Branches to the orbicular muscle and levators of the superior lip.
2. The Lateral Nasal Branch, uniting with the naso opthalmic, and forming a beautiful vascular plexus upon the alæ of the nose.
3. The two Nasal Branches of the Septum, rising upwards from the middle of the lip, and running as far as the point of the nose.

m. Two or three branches, uniting, under the levator labii superioris proprius, with the infraorbital, and the palpebral arteries.

D. The ASCENDING PHARYNGEAL of Haller—arises from the back part of the trunk near the lingual, or from the bifurcation of the carotid.

The auricular excepted, it is the smallest of the branches. It ascends upon the long anterior rectus muscle, to the foramen lacerum, through which it passes to be lost in the dura mater. The branches which it gives off may be divided, in regard to their situation,

a. Into those passing inward, viz.

1. Inferior Pharyngeal Branch---stretching down to the lower part of the muscular sac.
2. Middle Pharyngeal Branch---giving twigs to the larynx, pharynx, and Eustachian tube, after having united itself with the superior thyroid artery.
3. Higher Pharyngeal or Palatine Branch---distributing twigs to the superior constrictors, the stylopharyngeus, the Eustachian tube, and the pendulous velum; others to the rectus minor, the cuneiform bone, the cartilage occupying the anterior part of the foramen lacerum---and others to the internal nares and the pterygoid canal.

b. Those passing outward.—Of which the most remarkable are,

1. Branches to the first intercostal ganglion and the par vagum.
2. Branches to the sternomastoideus and the conglobate glands of the neck.
3. Branch passing through with the jugular vein, and extending its minute twigs to the cavernous sinus.

E. The OCCIPITAL ARTERY—passes transversely before the jugular vein, above the rectus lateralis, proceeding between the tranverse process of the atlas and the mastoid process, to the back part of the neck, and ascends, in widely spreading branches, to the occiput. In its course it is covered by the digastric, the trachelomastoid, the splenius, and complexus;

and becomes subcutaneous as it approaches the occiput. Its branches are,

a. One to the digastric and stylohyoideus.

b. Branches to the glands of the neck and the sternomastoideus, inosculating with the ascending thyroid artery.

c. Meningeal Branch—which enters the cranium along with the jugular vein, and is distributed to the dura mater of the cerebellum.

d. Auricular Branch—distributed to the lesser lobe, the helix, and concha.

e. Branches to the splenius and trachelomastoid. These send twigs to the recti obliqui and laterales.

f. A large Cervical Branch—passing to the exterior margin of the complexus, and descending between this and the trachelomastoid.

1. Superficial Branch---often descending to the middle of the neck; giving twigs to the splenius, complexus, and skin, at last inosculating with the transverse branches of the thyroid artery.
2. Deep Branch---distributed to the oblique, recti and complexus, and anasternosing with the vertebral artery under the transverse process of the atlas.

g. The artery, having now bent toward the vertex of the head, branches retrogradely to the splenius and complexus; whilst other branches extensively ramifying inosculate with the higher twigs of the temporal artery. Of these, one perforates the occipital ridge, and another the posterior mastoid hole—both to the dura mater.

F. The POSTERIOR AURICULAR, or STYLOMASTOID, rises from the trunk in the parotid gland, above the digastric muscle, and before the styloid process, then passes transversely to

the ear. As it curves behind the ear, it also inclines to the posterior part of the squamous bone, inosculating with the temporal, and occipital arteries. It sends,

a. Numerous branches, to the parotid gland, the digastric and sternomastoid muscles.

b. A branch through a particular opening to the membrane of the meatus auditorius.

c. The Stylomastoid Branch—passing through the stylomastoid hole, and sending off:

1. External branch to the cartilaginous meatus.
2. A branch which accompanying a twig of the articular artery of the maxilla, sends out the coronary branch, surrounding the osseous part of the meatus auditorius, and, descending ramifies beautifully on the membrane of the tympanum.
3. Branches to the mastoid cells, muscle of the stapes, external semicircular canal, and the auditory nerve.
4. Branch, anastomosing at the superior and posterior part of the tympanum with the meningeal branch, from the Fallopian aqueduct.

d. Minute branches to the sternomastoid muscle, the skin, and vertex of the head.

e. Branches behind the ear to the posterior auricular, the occipital and splenius muscles, and more deeply to the mamillary process, the pericranium, and the occipital bone.

f. A branch, winding on the posterior part of the concha, and there inosculating with the anterior auricular artery.

g. Higher branches, spreading beneath and above the temporal aponeurosis, and inosculating before with the temporal, and behind with the occipital branches.

G. The SUPERFICIAL TEMPORAL.—This artery, concealed at first in the parotid gland, stretches

above the zygomatic arch, between the jaw and meatus auditorius, and is at last extensively ramified over the side of the head. In this course are sent off,

a. A number of branches to the parotid gland, irregular in size and number.

b. The *Articular Artery of the Maxilla*—running to the back part of the meatus auditorius; sending branches to the joint, and two twigs, through the fissure of the articulation, to the muscle of the malleus, and, by inosculating with the stylomastoid, to form the other half of coronary artery of the tympanum.

c. Two or three masseteric branches, going to the masseter muscle, and afterward inosculating with the coronary artery of the inferior lip and the buccalis.

d. The *Transverse Artery of the Face*—rising from the parotid, it proceeds, with its gland, transversely to the face, giving branches to the parotid, the maxillary articulation, the masseter, the skin, the zygomaticus, and the orbicularis palpebrarum. It inosculates with the alveolar, palpebral, infraorbital, and coronary arteries of the upper lip: sometimes it gives masseteric branches.

e. The *Middle* or *Deep Temporal* Branch passes over the zygomatic arch, and is immediately covered by the aponeurosis of the temporal muscle; it extends to the anterior part of that muscle, to the external angle of the orbit, and inosculates with the palpebral artery.

f. The *Anterior Auricular* Arteries—given off above the middle temporal. Some of these perforate the meatus auditorius, and form a retiform plexus with the posterior auricular artery; others go to the helix and antihelix, the anterior auricular muscle, and meatus auditorius.

g. The *Orbicular* Branch—rising often from the temporo-frontal artery, passing above the zygomatic arch, sends a small branch, in a tortuous direction, to the external canthus of the eye, which, running under the orbicularis, reaches the internal angle. In this course, it inosculates with the palpebral and frontal branches, with the latter forming the superciliary arch.

h. The *Temporo-frontal*, or *Internal Anterior* Branch—ramifies extensively over the forehead, sometimes as far as the glabella. It sends branches to the orbicular, corrugator, frontal muscles, and aponeurosis.

i. The *Temporo-occipital*, or *External Posterior* Branch—bending behind the ear, it is the continuation of the trunk—its ramifications supply the occipital and lateral parts of the head; it inosculates with the occipital about the lambdoidal suture, with the temporo-frontal before, and above with the branches of the opposite side.

N. B. The Temporal Artery gives many minute branches to the pericranium, and bone.

H. INTERNAL MAXILLARY.—This artery larger than the temporal, rises about the middle of the ramus of the inferior maxillary bone, before the external pterygoid; and, bending inward, forward, and downward, is concealed by the maxilla. It then rises obliquely upward and forward, to the spheno-maxillary fissure. In this course it gives off

a. The *Deep Auricular* Artery—going to the posterior part of the meatus auditorius, and the neighbouring glands. It is sometimes wanting.

b. The Artery of the *Tympanum*—which passes through the fissure of Glasserus to the anterior muscle of the malleus.

c. The *Small Meningeal* Artery—running parallel to the middle meningeal, and giving branches to the external pterygoid, to the palatine muscles, and to the third branch of the fifth pair of nerves. It then passes through the foramen ovale, to the membranes of the cavernous sinus.

d. The *Middle Meningeal* Artery—stretching to the foramen spinosum, which it enters, and is there so ramified upon the surface of the dura mater, that some branches are carried transversely to the occipital bone, others to the posterior sinus of the falx, while others bend a little more anteriorly. All of these have frequent anastomoses with each other, with the posterior meningeal branches from the vertebral and occipital arteries, and with the anterior branches from the opthalmic. Before reaching the foramen spinosum, it sometimes gives branches to the sphenoid bone, to the dura mater, to the external pterygoid, and the muscles of the Eustachian tube. Having passed the foramen, it sends

1. Three or four branches to the junction of the petrous and squamous portions of the temporal bone.
2. Two branches passing through the aqueduct of Fallopius; one of them following the course of that canal, the other going to the internal muscle of the malleus, and the cavity of the tympanum.
3. Branches, which sometimes pass through a hole of the large wing of the sphenoid bone going to the os malæ and the lachrymal gland.

The meningeal artery sometimes sends off the *lachrymal* artery within the cranium.

e. The *Inferior Maxillary* Artery—in company with the nerve, enters the canal of the same name. It first sends branches to the internal pterygoid and the mylohyoideus; and is then distributed, in the

canal of the bone, to the teeth, and to the bone itself. Then passing through the mental hole it inosculates with the labial branches, and is expended upon the adjacent muscles and lip.

f. *Pterygoid* Branches—varing in number—to the pterygoid and buccinator muscles.

g. The *Deep External Temporal* Artery—before the trunk is concealed by the zygoma, gives a branch, which, in its ascent, rests upon the tendon of the temporal muscle, and terminates in this muscle and adjoining parts; while another, which some call the *masseteric*, is sent outward and forward between the processes of the maxilla, to the external pterygoid and masseter muscles.

h. The *Deep Internal Temporal* Artery—rising from the trunk, near the antrum Highmorianum, terminating in the temporal muscle, and transmitting a twig through the check-bone, to the fat and periosteum of the orbit.

i. The *Buccal*—irregular in its origin, arising, from the external deep temporal, from the alveolar, or from the infraorbital—penetrates the buccinator; and, winding on its surface, gives branches to the zygomaticus, the levator, the glands, and fat.

k. The *Alveolar* Artery—proceeding in a tortuous direction, above the alveolar processes of the superior maxillary bone, toward the cheek and face—where it gives,

1. Branches to the buccinator, fat, and internal surface of the cheek bone, and the gums.
2. Branches entering, by minute holes, the antrum Highmorianum.
3. The *Superior Maxillary* Artery of the Teeth—passing through the canal of the upper-jaw bone, and giving branches to the teeth.

l. The *Infraorbital* Artery—rising in the spheno-maxillary fissure, near the infraorbital groove; and, passing along this canal, emerges upon the face through the infraorbital hole. Before the

trunk reaches the canal, branches are distributed to the fat and dura mater of the orbit, to the lachrymal gland, and to the inferior oblique muscle of the eye. From the canal,

1. Branches go to the orbicularis, the lachrymal sac, and nose.
2. Branches, to the antrum, and its membrane.

Beyond the canal, and upon the face,

1. Branches anastomosing with the nasal, labial, the transverse, and buccal arteries.
2. Branches to the buccinator, the levator anguli oris, and the levator labii superioris.

m. The *Superior Palatine*, *Descending*, or *Pterygopalatine* Artery—rising from the trunk, which is divided into three branches at the spheno-maxillary fissure. It enters the ptery-gopalatine canal; and there, if not sooner, divides into two branches;

1. Posterior Branch---turning backwards through the posterior palatine hole, going to the extremity of the palate bone and the velum, and communicating with the ascending palatine.
2. Anterior Branch---larger than the last, passing forward under the roof of the mouth, and forming a vascular plexus in the palate. A twig ascends through the foramen incisivum to the nose, or inosculates with the descending nasal branch.

n. The *Highest Pharyngeal* Branch—rising in the above-mentioned place; stretching behind the sphenoidal sinuses, to the upper, posterior, and lateral parts of the pharynx—where it gives

1. Nutritient branches to the sphenoid bone.
2. Branch to the pterygoid hole, and inosculating with a branch from the internal carotid, the pharyngeal, or the middle meningeal arteries.
3. Branch to the cartilage of the Eustachian tube. I have sometimes found this pharyngeal branch entirely wanting.

4. The *Nasal* Artery—the last branch of the trunk, and often double, passing through the spheno-palatine hole, and dividing, at the superior and posterior part of the nose, into

1. Small branch, going to the posterior ethmoid cells.
2. Branches to the sphenoidal sinuses.
3. Larger branches to the septum of the nose.
4. Large branch, passing through the superior and inferior spongy bones to the bottom of the nose; giving twigs to the antrum and the membranes of the nostrils, and inosculating with the anterior palatine branch passing through the foramen incisivum.

(II.) The Internal Carotid, or Cerebral Artery—This artery, in rising to its canal, is connected before to the par vagum and intercostal nerves; and behind, to the rectus anticus muscle. Sometimes it forms above the vertebræ, a larger or a smaller projecting curvature. In this course no branches are, in general, given off. At last it enters the foramen carotideum; and, passing along this canal, undergoes many remarkable inflections. On its first entering the foramen, it proceeds upward, inward, and a little forward. It then rises from the canal forward and upward, at a very obtuse angle. Having at last reached the posterior part of the sella turcica, it bends in the cavernous sinus, so as to run in a horizontal direction to the anterior clinoid process. It here rises perpendicularly, perforates the internal surface of the dura mater, and proceeds, near the bottom of the brain, backward to the cerebrum.

Through this tortuous course, the five following branches are chiefly remarkable.

A. One to the pterygoid canal, inosculating with the highest pharyngeal of the internal maxillary.

B. A branch, to the cavity and promontory of the tympanum, and anastomosing with a twig of the meningeal, passing under the fissure of the aqueduct.

C. The posterior artery of the receptacle or cavernous sinus—rising from the transverse part of the carotid concealed in the cavernous sinus, and going to the dura mater which covers the posterior clinoid and the cuneiform processes; inosculating with branches of the vertebral artery rising without the cranium, and entering it through the foramen magnum.

a. Many branches, distributed extensively on the dura mater.

b. Branches to the 4th, 5th, and 6th, pairs of nerves.

c. Branches to the pituitary gland, its periosteum, and the cuneiform bone.

D. The anterior artery of the receptacle—rising above the origin of the intercostal nerve.

a. Branches to the 3d, 4th, and the three divisions of the 5th pair.

b. Many branches to the dura mater, and some to the pituitary gland.

E. The opthalmic artery—rising in the angle where the carotid artery leaves the sphenoid

bone, near its anterior clinoid processes; and running with the nerve which accompanies, and rests upon it, through the optic hole, to the orbit. Lying by the external side of the optic nerve, it passes obliquely forward over it; and reaching the internal angle of the eye above its adductor, divides it into two branches; and these into the following smaller branches:

a. The *Lachrymal*—rising about two lines after the opthalmic enters the orbit, between the abductor and the levator; then running above the abductor, proceeds to the lachrymal gland. It sometimes goes off from the middle meningeal artery.

1. A recurrent branch to the dura mater of the cavernous sinus, giving twigs to the fifth pair of nerves.
2. Branches to the periosteum of the orbit.
3. Branch to the levator palpebræ and the optic nerve.
4. Branch to the abductor.
5. Branch perforating the zygoma, and inosculating with the internal deep temporal artery.
6. Many branches, to the lachrymal gland.
7. The *Inferior External Tarseal* Branch---forming the Tarseal arch at the margin of the lower eyelid, with the inferior palpebral branch.
8. The *Superior External Tarseal* Branch---forming a similar arch with the superior palpebral branch.

b. The *Long Ciliary* Branch.—A description of the *Ciliary* arteries will be given below.

c. The *Supraorbital*, or *Superior Muscular* Branch—rises, while the trunk crosses the nerve; then bending to the levator palpebræ, proceeds forward, and, after passing through the supraorbitary hole, is distributed, upon the forehead, in two branches.

1. Branches going to the fuperior oblique, the levator, palpebræ, the superior recti, the sclerotic coat, and the periosteum.
2. Inferior Branch---widely distributed on the periosteum of the os frontis, and inosculating with the temporal and frontal branches.
3. External Branch---covered by the orbicularis, to which it gives twigs, and also to the corrugator. It forms many anastomoses with neighbouring branches.

d. The *Central* Artery of the *Retina*—rising from the inferior side of the opthalmic trunk as it lies upon the optic nerve; or sometimes from the ciliary arteries. It then sinks into the nerve; runs along its axis; penetrates, often double, the medullary expansion of the retina; and is extensively ramified on its internal surface. Of these, some extending as far as the corpus ciliare, form a circle between it and the vitreous humour, giving twigs to the crystalline; while a particular branch passes through the centre of the vitreous humour to the posterior side of the lens.

e. The *Long Internal Ciliary* Artery.

f. The *Inferior Muscular* Artery—rising from the trunk at the interior margin of the optic nerve, very often between the ciliary arteries, and transmitted, either under the eye, or above the adductor muscle, to the inferior palpebra.

1. Many branches to the deprimens oculi, adductor, optic nerve, and sclerotic coat.
2. Branches to the inferior oblique.
3. Branches inosculating with the infraorbital, and winding on the periosteum of the orbit.
4. Branches running to the inferior eyelid, the tunica adnata, and sometimes reaching the lachrymal sac.

g. The *Inferior Ciliary* Artery is wanting sometimes.

The three ciliary arteries mentioned above, commonly arise from the opthalmic artery, in such a way, that they follow the external and internal

margin of the nerve. There are sometimes six ciliary arteries, which, whether they arise from the opthalmic or its branches, spred into several ramifications, and enter the sclerotic in such a manner as naturally to form three classes.

1. Short, or Posterior Ciliary Branches, arising from the superior and inferior muscular branches, and from the ethmoidal, are often thirty in number; perforating the sclerotic coat, near the optic nerve, to the choroid.
2. Long Ciliary Branches. Two in number, entering obliquely the posterior part of the sclerotic, dividing into two branches as they approach the ciliary circle, and inosculating round the greater circle of the iris.
3. Anterior Ciliary Branches, rising either from the muscular, opthalmic itself, or the palpebral, accompany the recti; and, dividing at a little distance from the cornea into three or four branches, enter the sclerotic, and are distributed among the long branches on the uvea. To all these, forming a singular vascular plexus, the choroid coat, the ciliary circle with its processes, and the iris, owe their origin.

h. The *Posterior Ethmoidal* Artery—running between the levator and adductor, above the greater oblique; enters the posterior orbitary hole; passes through the cribriform plate into the cranium; and, reaching near the dura mater, inosculates with the anterior ethmoidal branches. The rest of the trunk is distributed to the nose.

1. Branch to the superior oblique and the adductor.
2. Branch to the posterior cells of the ethmoid and sphenoid bones, where it inosculates with branches of the internal maxillary nasal branch.

i. The *Anterior Ethmoidal* Artery—rises where the trunk, as it passes over the fourth pair of nerves, reaches the trochlea: then enters the anterior orbitar hole, and proceeds into the cranium through

a peculiar opening near the ethmoid cells, distributing some ramuli, to the nose.

1. Branches to the frontal sinuses, to the anterior ethmoidal and nasal sinuses, inosculating freely with the nasal branches.
2. Branches, distributed to the dura mater and the falx.

k. The *Inferior Palpebral* Artery—rising often along with the superior, where the trunk leaves the tendon of the superior oblique.

1. Branch to the tarseal ligament, angle of the eyelids, the caruncula lachrymalis, and the tunica adnata.
2. Branches to the anterior ethmoid cells, inosculating with the anterior ethmoidal, and passing with the infraorbital branch to the lachrymal sac.
3. Branches running along the margin of the tarsus, forming with the lachrymal the tarseal artery, or inferior tarseal arch.

l. The *Superior Palpebral* Artery—

1. Branches going to the superior part of the orbicularis, to the ligament of the palpebræ, and to the caruncula.
2. Branch, forming with the lachrymal artery, near the tarseal cartilage, the superior tarseal arch.

m. The *Nasal* Artery—rising over the superior part of the lachrymal sac and the ligament of the eyelids to the nose.

1. Branch to the glabella and frontal muscles.
2. Branch, passing down beyond the tarseal ligament to the lachrymal sac, then to the orbicular, and inosculating with the infraorbital.
3. Branch, running down on the side of the nose, and forming a beautiful plexus by frequent communications with the labial arteries. Passing through the bone and nasal cartilage, it is lost on the pituitary membrane.

n. The *Frontal* Artery—at first subcutaneous—passes over the orbicular muscle, then sinks in the corrugator. Its braches are,

1. Superciliary Branch---to the eyebrows and muscles; and inosculating with the temporal and lachrymal arteries.
2. Superficial Frontal Branch---extensively distributed on the glabella, and rising as high as the fontanelle or bregma.

Deep Frontal Branch---to the pericranium by many ramuli.

F. MINUTE BRANCHES to the optic nerve, infundibulum, pituitary gland, and the lower part of the choroid plexus.

G. The COMMUNICATING ARTERY.—This, along with the deep branch of the vertebral artery of the cerebrum, forms the circle of Willis. It proceeds straight backward and inward, by the side of the corpora mammillaria, near the infundibulum, where it reaches the artery already mentioned, and there forms an obtuse angled quadrangle. It varies in size, and sends

a. Branches to the corpora mammillaria.
b. Branches to the infundibulum.
c. Branches to the optic nerve.
d. Branches to the crura cerebri, inosculating with the posterior carotid.

H. The ANTERIOR CAROTID ARTERY, or ARTERIA COLLOSA.—The internal carotid, at that place where the anterior lobe of the brain is separated from the posterior, divides into two branches of nearly equal size; of which the anterior proceeds immediately inwards, and a little forwards; then bends above the corpus callosum, between the hemispheres, to the posterior lobes of the brain: in which course it gives

a. Branches to the optic and olfactory nerves.

b. Many branches, winding outward to the anterior lobes of the brain.

c. A Communicating Branch—short and transverse inosculating with its fellow of the opposite side. This branch sends.

1. Branch to the anterior part of the third ventricle.
2. Branch to the fornix, the anterior commissure and the septum lucidum.
3. Branches to the pia mater.

d. Branches to the inferior and internal side of the anterior lobe. They follow the convolutions of the brain, and inosculate with the posterior carotid.

e. Many branches to the corpus callosum and cerebrum, forming inosculations in the posterior lobe, with the posterior carotid and vertebral arteries, and extending even to the tentorium.

I. The POSTERIOR CAROTID, or the ARTERY of the FOSSA SYLVIANA.—Enters the fossa Sylvii, and gives to each numerous superficial and deep seated branches to both lobes of the brain.

a. Branches to the optic nerve and choroid plexus.

b. Branches to the pia mater, covering the basis of the brain.

c. Numerous branches, inosculating with those of the former trunk, the vertebral artery, and amongst themselves.

DISTRIBUTION OF THE SUBCLAVIAN ARTERY AND ITS BRANCHES.

The division of the right and left subclavian arteries differs only in this respect, that the right subclavian is much larger, passes obliquely over

the trachea, and sends off the common carotid. Having left this branch at the side of the trachea, it is now more properly the right subclavian; and, still continuing larger than the left, proceeds nearly in a transverse direction. The left subclavian, on the other hand, while it gradually ascends from the inclining part of the arch, passes on to its place of destination with a more rapid and extentensive curvature.

These two arteries run in such a direction, above the superior margin of the first rib, as to be concealed for some time by the clavicle. They then proceed, with the brachial plexus, across that space lying between the first and second scalene muscles; and, being covered by the flattened extremity of the clavicle and the pectoral muscle, bend to the axillæ, where they take the name of *Axillary Arteries*. The branches of the subclavian arteries, and their ramuli, present so many varieties, that no description, either as to their number or their direction, can in every respect correspond with Nature. In general, however, the four first branches arise before the artery sinks under the scalenus, while the rest are sent off beyond the margin of this muscle. These are,

A. The INTERNAL MAMMARY ARTERY—going off from the lower and anterior part of the trunk, at the highest part of the pleura, where, ascending gradually, and again bending downwards to the sternum, it reaches the margin

of the first rib, under which it passes; and, running between the pleura and middle part of the cartilages of the ribs, descends between the internal intercostal and their sterno-costal muscles, as far as the diaphragm. It then passes between the diaphragm and the ribs, and, dividing into many twigs, is lost under the rectus of the abdomen. From its origin to the third rib, it bends towards the sternum, then gradually inclines outwards. Its branches are,

a. A Recurrent Branch—passing in the direction of the clavicle to the muscles of the neck, and distributing to these muscles small irregular ramuli.

b. The *Thymic* Branch—which is often double, and varies very much in distribution of its twigs to this gland; which also receives arteries from those of the mediastinum and pericardium.

c. A branch accompanying the *phrenic nerve*—of small size, supplying the neighbouring parts with twigs, and afterwards uniting at the diaphragm with the phrenic artery of the aorta.

d. The *Superior* and *Posterior Pericardiac* Branch—rising sometimes from the mammary, and sometimes from the subclavian artery; sometimes from the aorta or from the common carotid; and as it winds to the upper and back part of the pericardium, distributes itself upon the trachea, the glands, the coats of the pulmonary artery, the pericardium, and œsophagus.

e. Many Mediastinal Branches—rising between the the third and sixth ribs; some of which go to the thymus gland, and a larger one to the diaphragm.

f. Sternal Branches—spreading variously on the back of the sternum, and uniting with branches from the opposite side.

g. Smaller branches to the pericardium and glands, lying on the vena cava.

h. Many branches *to the adjoining surface of the* LUNGS.

i. Many branches going outwards, entering the intercostal spaces of the six superior ribs; the first of which are bent to the sternomastoid, the sternohyoid, and the sternothyroid. Others form, at each interstice of the ribs, along with the thoracic and intercostal arteries, double inosculating rings; and others, arising from these *annuli*, go to the intercostal and pectoral muscles, the mammæ, the obliquus descendens, and the skin.

k. The *phrenico-pericardiac* branch — descending above the pericardium to the diaphragm, and sometimes stretching near the ensiform cartilage to the rectus muscle.

l. The *musculo-phrenic*—rising in a large branch at the sixth interstice of the ribs, turns outwards, between the cartilages and the sternocostal; then proceeds obliquely to the interstices of the seventh, eighth, and ninth ribs, where it forms inosculating rings with the inferior intercostal arteries; and here sending many twigs to the diaphragm, at last spreads at the tenth rib on the transverse muscle of the abdomen.

m. A branch, winding on the surface of the ensiform cartilage, and inosculating with the branches of the opposite side, or going down as far as the rectus muscle. Sometimes passes through the ensiform process.

n. The *epigastric* branch.—A continuation of the trunk: as it leaves the thorax by the side of the ensiform cartilage of at the seventh rib, is covered by the abdominal muscles, and divided into

1. An Internal Branch, going down to the rectus muscle, often as far as the umbilicus, and inosculating with twigs of the *epigastric*.
2. An External Branch, going to the transversa-

lis, and inosculating with the epigastric, intercostal, and lumbar arteries; sometimes sent from the musculo-phrenic; and if that be smaller, this supplies it with many branches.

B. The INFERIOR THYROID, or ANTERIOR CERVICAL ARTERY—rising from the forepart of the trunk, near the mammary and vertebral arteries; and being covered by the sternomastoid, and bent a little upwards and outwards, immediately divides into four principal branches—

a. The *Transverse Scapular*—the lowest branch of the thyroid artery, but sometimes of considerable size—is covered at first by the sternomastoid, and passes transversely to the scapula, under the trapezius. The *superficial cervical* sometimes supplies the place of its superior scapular branch.

1. Branches going separately to the sternomastoid, the sternohyoid, the omohyoid, and the subclavian muscles, the coats of the arteries and veins, and the skin of the neck and breast.
2. The *Superficial Scapular* Branch---giving twigs to the integuments on the top of the shoulder and surface of the trapezius and deltoid.
3. Branches to the posterior part of the trapezius.
4. Branches to the levator scapulæ, and the serratus.

Thus is the artery often wholly expended. At other times, it sinks deep under the trapezius, in many tortuous windings, where it properly takes the name of *superior scapular*, or *dorso-scapular*; and is chiefly divided into two smaller trunks, sending previously off

1. Branches to the subclavian and adjoining part of the trapezius muscle.
2. Branches to the lesser portion of the serratus major anticus, and adjoining rhomboid, near the superior angle of the scapula.

3. A branch, running upon the surface of the supraspinatus to the concave side of the acromion; inosculating, near the coracoid process, with the *humeral thoracic* of the axilla, and again communicating at the superior angle, with the *superficial artery* of the *base*.
4. A branch, passing over the outer surface of the spine of the scapula; and after giving twigs to the bone and the neighbouring muscles, inosculating with the *inferior circumflex scapular* in the infraspinal cavity.

Under the Trapezius, it divides into

1. The *Superspinal*---the first branch of the divided artery, passing through the *semilunar notch*, and distributing many twigs to the supraspinatus, is continued onwards, in two branches, under the acromion process, and supraspinatus, where it begins to send branches to the scapula itself, the capsular ligament, the infraspinatus, the teres minor, and at last inosculates with the *inferior circumflex scapular*.
2. The *Superficial* Branch of the base of the Scapula---larger---proceeds near the lower part of the levator scapulæ to the base, and, going down between the serratus major and the rhomboid, reaches the inferior angle of the scapula. In this course, it gives many branches to the rhomboid and serratus; and through them to the trapezius, the serratus posterior, the skin, and subscapular muscle: afterwards forms, near the inferior angle, with the *inferior scapular* branch, a beautiful circle upon the surface of the serratus; from which branches descend to the latissimus dorsi.

Thus does the above remarkable artery, as well as the *superspinal*, arise often from the *superior* or *dorso-scapular*. I have observed, however, that the *transverse scapular* sometimes sends off the *superspinal* branch only, and that the other proceeded from the *superficial cervical* artery.

b. The *Transverse Cervical*—running, by the side of

the neck, transversely and upwards, to the cervix, where it is concealed by the trapezius. Its various branches sometimes arise from the *superficial cervical* artery.

1. Branches to the sternomastiod and skin.
2. Branches to the trapezius, levator scapulæ, and splenius.
3. A large branch, ascending between the splenius and trapezius, giving ramuli to both these and the complexus, and at last inosculating freely amongst the muscles with the descending branch of the principal *occipito-cervical* artery.
4. A branch, descending to the trapezius, rhomboid, complexus, and supraspinatus muscles, and inosculaing with the *superficial cervical* and the *transverse scapular* branches.

c. The *Ascending Thyroid* Artery—rising between the rectus anterior and scaleni muscles, upon the forepart of the transverse processes, as high as the second vertebra; varying in size and in the number of its branches. It exhibits

Superficial branches. From which

1. Branches are sent, transversely and outwards, to the angularis, splenius colli, sternomastoid, and scaleni muscles.
2. Branches to the rectus, winding variously on the anterior surface of the vertebræ.
3. Branches to the tenth pair of nerves and the ganglion olivare; inosculating with the pharyngeal artery.

Deep branches, which are sunk between the vertebral interstices as the artery ascends. Of these are reckoned,

1. Branches to the intertransversarii, scaleni postici, and the origin of the splenii muscles.
2. Branches passing through the openings for the intercostal nerves to the *involucra* of the spinal marrow, and inosculating with twigs of the vertebral artery.

d. *The Thyroid Branch of the Thyroid Artery.*—In this the whole trunk is expended. It bends under the carotid to the side of the larynx; and, after repeated windings, reaches the inferior part of the thyroid gland. It sinks into the gland; and, while it divides into many ramifications, is partly distributed to the whole gland, and partly inosculates with the *superior thyroid.* It gives,

1. Lesser branches to the outer muscles of the os hyoides and larynx, to the superior cartilages of the trachea, and the inferior thyroid ganglion. Of these, the branches which go to the larynx form the *inferior laryngeal.*
2. Pharyngeal branches to the inferior constrictor muscles, the œsophagus, and the posterior muscles of the larynx,
3. The *Superior Tracheal* or *Thoracic* Branch---often double or triple. One of the branches, descending with the trachea into the cavity of the thorax, and there forming above the trachea a beautiful plexus, communicates with the *inferior bronchial* and the *higher intercostal* branches.

C. The SUPERIOR INTERCOSTAL ARTERY— rises more externally than the *vertebral,* from the upper and posterior surface of the trunk; then ascends with it to the hollow that is formed by the anterior scalenus, the surface of the first rib, and bodies of the vertebræ. It is there suddenly reflected; and, proceeding to the roots of the first and second ribs within the thorax, gives,

a. Ascending branches, irregular in number and size, to the scaleni, the longus colli, and the nerves.

b. Branches to the intercostal muscles of the first and second interstices, which run along the margins of the ribs, forming circular inosculati-

ons with the *higher thoracic* branch and the branches of the *internal mammary*.

c. Numerous *Oesophageal* Branches—inosculating with the *superior tracheal* branch of the *thyroid* artery.

d. Branches sent through the openings for the nerves to the hollow of the spine, and there distributed both to the *involucra* and the medulla.

e. Branches passing over the third rib, and inosculating with twigs of the *first inferior intercostal*.

f. Deep branches, passing through the intercostal spaces to the deep muscles of the back and neck.

D. The VERTEBRAL ARTERY—larger than the former, rises from the superior side of the *subclavian*; and, ascending a little backwards, covered by the ganglions of the intercostal and the cellular membrane, reaches the perforations of the transverse processes of the cervical vertebræ. Through these it penetrates, and, rising perpendicularly from the sixth, or sometimes from the fifth or fourth opening, reaches the aperture of the atlas, where it bends a little outwards; and having passed through, undergoes another more extensive flexion backwards and inwards, by which it is carried transversely in a groove, between the occipital bone and the atlas, to the foramen magnum. Through this opening, having at last entered the cranium, it proceeds upwards and forwards, and at the basilar apophysis, under the medulla oblongata, meets, at an acute angle, with the vertebral artery of the opposite side, forming the *basilar artery*.

to be distributed to the cerebrum and cerebellum. It gives, in this course,

a. Lateral branches to the muscles between the transverse processes, and others, near to the vertebræ.

b. Larger branches passing through the intervertebral openings for the nerves, to the coverings of the medulla, and inosculating with the anterior and posterior spinal branches.

c. A branch going, with various twigs, from the first bend of the artery to the rectus posticus major and minor, the obliquus major and minor, the trachelomastoid, and complexus; and inosculating with branches reaching from the occipital artery.

d. *Posterior meningeal* branches—proceeding from the second and third flexures, and winding forwards upon the dura mater of the cerebellum, as far as the clinoid processes and receptacle, and backwards towards the occiput.

Before the formation of the *basilar artery*, there are sent off in the cranium itself—

e. The *inferior artery of the cerebellum*—issuing at a right angle from the trunk, near the medulla oblongata, between the tenth and accessory nerves. It not only distributes many branches to the lower surface of the cerebellum, but, being concealed between the medulla oblongata and the crura of the cerebellum, is so bent backwards and upwards, as to terminate in the vermiform process of the cerebellum and fourth ventricle. In this course are given,

1. Branches to the tenth and eleventh nerves.
2. Branches to the anterior and lateral surfaces of the medulla oblongata, and corpora olivaria.
3. Branches to the posterior surface of the me-

dulla oblongata, and the choroid plexus of the fourth ventricle.

f. Branches sinking into the furrow that separates the corporapyramidalia from the tuber annulare.

g. The *posterior spinal* artery—rising often from the inferior artery of the cerebellum; and, bending from the anterior to the posterior surface of the medulla oblongata, descends tortuously on the spinal marrow, and inosculates freely in its descent with its fellow and with other branches, as they pass to the medulla through the openings for the nerves. It terminates on the surface of the medulla at the second lumbar vertebræ; and through its whole course supplies, with minute twigs, the medulla, and its several nerves, as they pass out.

h. The *anterior spinal* artery—rising, at an acute angle from the trunk, near its fellow, and, descending in a retrograde course, proceeds in a winding direction upon the anterior surface of the medulla, inosculating by transverse branches in the region of the neck and back with the artery of the opposite side, to which it is parallel. The two arteries at last uniting near the termination of the medulla, form a trunk, which is sent to the extremity of the os sacrum; and which, if emptied of its blood, assumes the appearance of a nerve: whence the ancient error as to a *nervus azygos*. It distributes numerous branches to the neighbouring parts, and to the nerves as they go out, and enters into frequent anastomoses with the spinal branches, penetrating the interstices of the vertebræ.

The BASILAR ARTERY, being formed as above, occupies the depression in the middle of the tuber annulare, and at its interior part divides

into four parallel branches, proceeding from the trunk at right angles. Of these, the posterior go to the cerebellum; and the two anterior, ramified on the cerebrum, unite with the *communicating arteries* of the carotid, and form the great circles of Willis. From the trunk

a. Many branches proceed, transversely and outwards, distributed to the surface of the medulla oblongata, the corpora olivaria and pyramidalia, the tuber annulare, the inferior surface of the cerebellum, and the neighbouring pairs of nerves. Of these, a branch, accompanying the auditory nerve, passes to the labyrinth of the ear.

b. The *deep arteries of the cerebellum*—Right and Left—winding behind the crura of the cerebrum to the superior part of the cerebellum, and there exhibiting,

1. A short anterior branch---distributed to the crura cerebelli, the cerebellum, the vermiform process, and the choroid plexus, lying on the thalami.
2. A middle branch---winding extensively on the upper side of the cerebellum; inosculating freely with the *inferior* of the cerebellum; entering the different *sulci*, and supplying the thalami, nates, testes, and pineal gland.
3. A deeper branch---following the same course, spreading, with minute twigs, on the crura cerebri, the thalami, nates, pineal gland, choroid plexus, the processes of the cerebellum at the testes, the valve of Vieussenius, and the fourth ventricle.

c. The *deep artery of the cerebrum*—larger than the last, and separated from it by the third pair of nerves. Turns upwards along with the former between the cerebellum and posterior lobe of the cerebrum; and gives,

1. Smaller branches, running to the bottom of the third ventricle, the thalami, optic nerve, the mamillary eminences, the corpora quadrigemina, and fornix.

2. *Communicating* branches forming the circle of Willis, and frequently of unequal size. They proceed forwards, almost at a right angle, to meet the *communicating artery* of the carotid, and give minute twigs to the adjacent parts.

3. A branch, going to the sides of the crura of the cerebrum and the lateral ventricle, and distributing small branches above the thalami, to the corpora quadrigemina, the pineal gland, the choroid plexus covering these parts to the fornix, the corpora striata, and the third ventricle.

4. A branch, the greatest part of which is sent, immediately with its very numerous twigs, into the sulci of the posterior lobe; from which, again, smaller ramifications arise, to be distributed, as in Number 3, to the corpus callosum and septum lucidum.

5. Branches, representing the continuation of the trunk, and inosculating with ramuli of the carotid.

E. The DEEP, or POSTERIOR CERVICAL ARTERY—Irregular in its origin, size, and extent, and, like the *superficial cervical*, or *transverse scapular* of the thyroid, spreads, sometimes more, and sometimes less extensively, with its branches. I have sometimes observed it the smallest of all, and proceeding from the *superior intercostal*. It generally issues from the *subclavian*, beyond the margin of the scalenus, though sometimes sooner under this muscle. It then winds upwards and backwards, between the deep muscles of the neck and the sixth verteba; and is at last so dispersed among the muscles, as to bestow its

ultimate branches on the complexus, near the occiput. It usually gives,

a. Branches winding on the surface of the bodies of the vertebræ.

b. Branches distributed to the scaleni muscles.

c. Branches to the spinal muscles of the neck, the trachelomastoid, splenius, and intertransversarii.

d. Branches to the complexus, often interwoven with the occipital branches.

D. The SUPERFICIAL CERVICAL—rises about half an inch, or an inch, from the first scalenus, at the upper and anterior side of the subclavian where it begins to bend downwards; immediately hides itself among the brachial nerves; and, spreading out afterwards, toward the superior costa of the scapula, divides into many irregular branches. Of these, the most remarkable are,

a. Branches distributed amongst the scaleni and brachial nerves.

b. A Transverse Branch—bending upwards under the levator, and sending superficial branches to this muscle, the trapezius, and skin, and deeper ones to the splenius and complexus. If larger than usual, it runs in the direction already mentioned, and sends out either the *superspinal* or the *superficial of the base* of the scapula. It generally forms many anastomoses with the branches of the thyroid and the *deep cervical.*

DISTRIBUTION OF THE AXILLARY ARTERY.

The Subclavian Artery, as it bends from its first situation, between the breast and scapula,

to the humerus, assumes the name of AXILLARY. Passing out, under the arch of the clavicle, it is surrounded by the nerves of the brachial plexus, the veins, glands, and a quantity of fat; lies in the hollow of the axilla, between the subscapular and serratus major; and protected externally by the pectoral muscles, it soon approaches forwards to the arm and the interior margin of the biceps. At last, proceeding from the axilla to the inferior border of the tendon of the latissimus dorsi, it takes the name of HUMERAL ARTERY. It sends off,

A. SMALL BRANCHES to the scalens, first rib, coracoid process, the adjacent muscles, and nerves.

B. The HIGHEST THORACIC BRANCH—arising above the second rib, or at the inferior margin of the first, and distributed in the upper region of the thorax, between the serratus and small pectoral—divides into,

a. A Transverse Ascending Branch—covered by the serratus, to which it sends a recurrent twig, and inosculates twice or thrice at the first interstice of the ribs with the *internal mammary* and *superior intercostal.*

b. A branch, going down beyond the second and third interstices, and at last receiving some twigs of the *long thoracic*. From this proceed,

1. A large branch to the serratus magnus.
2. Two branches, uniting at the second intercostal space with the *internal mammary* and *intercostal.*
3. Two branches to the third interstice, where this ramus generally terminates.
4. Branches to the pectoral muscles and skin.

C. The LONG, or SUPERIOR THORACIC or EXTERNAL MAMMARY—running down as far as the fifth costal interstice. It sometimes arises from the *circumflex*, or from the *inferior scapular*.

a. Branches to the glands of the axilla and mamma, running sometimes to the nipple.

b. Many branches, irregular in series and situation, to the serratus major and minor; and, passing the second and fourth interstices, to the great pectoral and mamma, anastomosing with the *highest thoracic*.

c. Branches sinking deeper, forming double circles with *internal mammary*, and the *inferior intercostal*, as low as the interstice of the fifth rib, and sending branches to the intercostal muscles.

D. The HUMERAL THORACIC—rising from the anterior part of the trunk, between the second rib and the coracoid process, to the upper margin of the lesser pectoral; penetrates the interstice of the deltoid and pectoral muscles; and in its course sends,

a. A deep branch to the serratus major.

b. Branches to the deltoid, to the great pectoral and subclavian muscles, and rising above the clavicle, to the neck.

c. A branch, running along the subclavian muscle to the pecroral; and, in the space between this and the deltoid, distributing its branches to the pectoral muscle, the clavicle, and skin, and at last inosculating with the *transverse scapular*.

d. Another branch to the pectoral and deltoid.

e. A branch near the coracoid process, descending to the axillary glands.

f. A Circumflex Branch—winding backwards, under the muscle, round the origin of the deltoid. From which proceed,

1. A Cutaneous Descending Branch---attending the cephalic vein, and terminating at the top of the humerus and the pectoral muscle.
2. A Superficial Branch---passing along the outer edge of the deltoid, and the adjoining margin of the acromion.
3. A Deep Branch to the articular capsule, the coracoid process, and the deltoid.
4. A branch to the spine of the scapula, uniting with the *superspinal thyroid* and the *posterior axillary circumflex.*

E. The ALAR THORACIC.—This artery is sometimes wanting, though at other times it is large, and sends numerous branches to the axillary glands, and some also, spreading extensively in various directions, to the subscapular, pectoral, and serratus.

N. B. The number and distribution of the thoracic arteries are so irregular, that anatomists have sometimes enumerated six separate trunks distributed to the thorax.

F. Two or more large branches, rising near the upper and inferior margin of the scapula, sending twigs to the nerves, serratus, levator scapulæ, latissimus dorsi, and particularly the subscapular; inosculating, partly with the *superficial thyroid scapular* of the base, and partly disappearing among the muscles.

G. The INFERIOR SCAPULAR, or INFRASCAPULAR, or SUBSCAPULAR—rising at the inferior margin of the subscapular muscle, divides

into conspicous branches, which run in various directions. Arises, also, sometimes among the thoracic branches, when, bending downwards, it sends

a. A branch to the surface of the subscapular, the capsular ligament, and the muscles attached to the coracoid process.

b. A deep branch—winding, with its twigs, through the subscapular to the naked scapula, after giving twigs to the teres major and latissimus dorsi.

c. A muscular branch—large, and sometimes rising separately. Sending branches to the subscapular extening as far as the base of the scapula; and, distributing extensively large branches to the teres major, the serratus, the latissimus dorsi, and axillary glands.

d. A Conspicuous Branch—running closely along the margin of the subscapular, and forming at the inferior angle of the scapula, which it traverses, a large circle with the *superficial thyroid scapular* of the base. It rises sometimes from the muscular branch.

e. A branch, parallel to the inferior costa, and extending to the teretes, the long extensor, and the glands.

N. B. All these branches present frequent variations, and often distribute more ramuli, which, for the sake of conciseness, I omit.

f. The *Scapular Circumflex*.—The branches already enumerated having supplied the inner part of the scapula, this large trunk bends between the inferiór costa of the scapula and teres major, to the infraspinal cavity, near the cervix, and proceeds, under the teres minor and infraspinatus, to the spine; giving

1. Branches to the teretes and long extensor or scapular head of the triceps.
2. A number of Descending Branches---winding in the hollow, as far as the base of the scapula, and inosculating with neighbouring twigs.

3. An Ascending Articular Branch---between the neck and spine of the scapula: which sends

a. Branches to the infraspinatus.

b. An Anastomotic Branch---uniting with the *superspinal thyroid.*

c. A Coronary Branch to the spine and capsular ligament,

d. A Branch to the supraspinatus, where it inosculates again with the *superspinal.*

e. A branch to the deltoid.

H. The POSTERIOR CIRCUMFLEX ARTERY—issuing between the subscapular and teres major; it sinks between them, winds round the neck of the humerus, under the long extensor, and afterwards bends transversely, under the deltoid, backwards and outwards, from the inner side of the arm. It sometimes gives rise to the *anterior circumflex,* and the deep branch of the humerus, or *humeral profunda*; and sends

a. A branch to the capsule and the circumflex nerve, which it accompanies.

b. A branch to the coracobrachial, internal anconeus, and the teres minor.

c. Branches to the humerus and bicipital groove.

d. Many branches to the subscapular, the long anconeus, the back of the scapula, and the bone.

e. A branch, variously ramified on the capsule, the anconeus, and periosteum; anastomosing freely with branches from the *subscapular,* and running transversely, in a circular course, to the deltoid.

I. The ANTERIOR CIRCUMFLEX ARTERY—of smaller size—sent out near the former, above the teres major, proceeds round the humerus, under the biceps and coracobrachial, to the outer part of the arm, where it either disappears under the deltoid, or enters this muscle; and sends

a. Many branches to the subscapular, the latissimus dorsi, and the long extensor. They are often wanting.

b. Branches to the bone and periosteum, inosculating with the *profunda*.

c. Branches to the biceps, capsule, coracobrachial, and deltoid.

d. A branch, sunk in the bicipital groove; and, at the capsular ligament, inosculating, by an ascending twig, with the superior branches of the *posterior circumflex*, and, by a descending twig, with the deep branch of the *humeral profunda*, in the bicipital groove.

e. A Branch to the deltoid; but which is often wanting.

DISTRIBUTION OF THE BRACHIAL OR HUMERAL ARTERY.

The Axillary Artery is first known by the name of Humeral or Brachial, where it proceeds from the axilla to the internal side of the arm. Having left the cavity of the axilla, and passed to the internal surface of the tendon of the teres major, it continues its course above the internal brachial to the inner side of the biceps, and gradually runs along the middle of the arm to the anterior surface of its extremity; where at last, concealed under the aponeurosis of the biceps, it divides, near the bend of the fore-arm, into the Ulnar and Radial Arteries.

A. A branch—going down, near the tendon of the teres major, under the coracobrachial, to the bicipital groove, and giving recurrent twigs to the head of the humerous and capsule.

B. Branches to the long and internal anconei, and coracobrachial.

C. Many BRANCHES—going out in various places, to the biceps, the internal brachial, and bone.

D. The DEEP BRANCH of the HUMERUS; the LARGE COLLATERAL, or LARGE HUMERAL PROFUNDA—sometimes double—rising, from the inner side of the trunk, at the inferior margin of the teres major; but sometimes sooner, from the *inferior scapular* or *posterior circumflex*. It proceeds backwards, with a gentle curve; and, accompanying the long extensor, runs to the cavity between the anconei muscles, where, in the passage of the spiral nerve, it divides into two branches, at the upper junction of the external anconeus and internal brachial. It gives

a. A branch to the long and external anconei.

b. A branch to the biceps, coracobrachial, the periosteum, the tendon of the teres major, and the deltoid; inosculating with twigs of the anterior circumflex, and with other branches of the *humeral* artery.

c. A branch, ramifying on the coracobrachial, internal brachial, the bicipital groove, and the bone.

d. Many distinct branches, sent off from the trunk in its descent; some of them ascending to inosculate with branches of the humeral and scapular arteries, and others descending to be ramified on the muscles.

e. The *Large Communicating Radial, or Profunda-radial.*—The external branch of the divided trunk, which, winding between the external anconeus and brachial to the spine of the condyle, forms, around the external or *extensor* condyle, anastomotic arches with the *radial recurrent*, the *lesser profunda*, and *superior interosseal perforant.*

1. Branches to the neighbouring muscles.
2. Nutritious branches, winding on the periosteum.
3. Cutaneous branches, emerging through the interstices of the muscles.

4. Branches, inosculating, on the posterior and anterior surface of the condyle, with the radial recurrent and interosseal branches.
5. A Deep Branch---covered by the radial extensor and long supinator, and forming many inosculations with the *radial recurrent* and *lesser profunda*.

f. The *Large Communicating Ulnar*, or *Profunda-ulnar* —the interior and deeper branch of the divided trunk, bending between the internal anconeus and brachial, to the internal or *flexor* condyle; and sending

1. Branches to the anconei and coracobrachial; inosculating with a branch of the *humeral*.
2. A branch, passing out between the humerus and anconeus to the deltoid, the internal brachial, and the skin. It is often wanting.
3. Deep Branches to the adjoining muscles, and communicating under them with the *dorsal arch*. Some of these inosculate, near the elbow, on the internal anconeous, with the *large anastomotic*; others communicate with the *brachial arch*, winding on the back of the condyles; and others with the *ulnar recurrent*.

E. A BRANCH to the coracobrachial and internal brachial.

F. A BRANCH—descending on the surface of the internal anconeus, and communicating, near the bend of the elbow, with the *ulnar recurrent*, the *great anastomotic*, or sometimes with both.

G. A BRANCH—which, after having sent off twigs to the adjoining anconei and coracobrachial muscles, proceeds upon the inner surface of the arm, as far as the olecranon, and inosculates with branches of the *ulnar recurrent* and *dorsal arch*.

N. B. These two branches are usually called the LESSER COLLATERAL.

H. BRANCHES ramified on the biceps and coracobrachial, irregular both in number and origin,

and distributing their twigs both upwards and downwards.

I. The LARGE NUTRITIOUS ARTERY of the humerus—arising at the inferior part of the coracobrachial, bending outwards, and sending off

a. A branch to the external anconeous and skin; inosculating with the other branches distributed to that muscle.

b. A deep branch to the internal brachial, at last terminating in the deltoid.

c. Branches entering the bone in several places.

d. Branches, inosculating, at times, with the *large anastomotic* or *lesser profunda*.

K. The LESSER PROFUNDA—rising externally from the trunk; penetrating the internal brachial, and winding between the supinator and the radial extensor, to the outer or *extensor* condyle. By its ascending twigs, it inosculates with the *nutritious*, and by its descending, with the *radial recurrent*. These likewise pass sometimes to the articular ligaments.

L. The LARGE ANASTOMOTIC—rising, sometimes double, from the internal side of the trunk, a few inches above the joint; but immediately dividing, it passes, in a tranverse course, upon the surface of the internal brachial, to the flexor condyle, where, perforating the intermuscular ligament, it runs upwards to the cavity, between the condyle and olecranon, covered by the tendon of the triceps and the ulnar flexor of the carpus. It sends off

a. An *Ascending* Branch—sinking in the anconeus, and anastomosing with the *large communicating ulnar*.

b. A *Descending* Superficial Branch—to the pronator, sublimis, and internal brachial. It inosculates with superficial twigs of the *ulnar recurrent;* and, after perforating the muscle, again anastomoses, upon the periosteum and capsule of the fore-arm, with branches of the *radical recurrent*, where it forms, around the articulation, the *anterior arch.*

c. Many cutaneous branches to the brachial muscle and *flexor* condyle.

d. A Deep *Descending* Branch—anastomosing, anteriorly, with the *ulnar recurrent*, and posteriorly with the same *recurrent* and *interosseal* artery.

e. A *Transverse* Branch—which, with the *profunda-ulnar*, the *profunda-radial*, the *lesser profunda*, and all the *recurrents*, forms, above and below the condyle, the *posterior dorsal arch* of the humerus. This arch distributes many branches to the joint and the neighbouring parts.

M. Smaller branches to the internal brachial, and the muscles arising from the flexor condyle.

The Ulnar Artery.—The *humeral artery* sometimes undergoes the division already mentioned at the middle of the humerus, or even higher. This, however, is the largest artery which arises from the trunk at the bend of the arm. Scarcely has it arisen, when it sinks deep into the cavity that is occupied by the tendon of the biceps, the nerve, blood-vessels, and fat. It then bends, near the interstice of the bones, under the pronator teres, radial flexor, palmaris longus, and sublimis, to the lunar side of the fore-arm, proceeding gradually, with many deflections, between the sublimis, the profundus,

and ulnar flexor to the wrist. Passing over the wrist, it forms the *superficial arch* of the hand, which gives beautiful arteries to the fingers, and finally inosculates at the palm with the radial artery. The more remarkable branches which it sends off are,

A. A BRANCH to the pronator teres and the common head of the flexors.

B. The HIGHEST INTEROSSEAL PERFORANT—going first to the internal brachial and capsule, where it forms the *anterior arch*, by a branch inosculating with the *anastomotic* and the *radial* and *ulnar recurrents*. After perforating the interstice of the bones, it sends, under the small anconeous, a number of recurrent branches upwards to the *dorsal arch*, and downwards to the extensor muscles. The whole artery often rises from the *common interosseal*.

C. The ULNAR RECURRENT—sent off from the ulnar side of the trunk, a little above the *common interosseal;* and, having passed through the flexor muscles, is reflected to the posterior part of the internal condyle. In which course are distributed,

a. A branch to the capsule, the flexor muscles, and ulna.

b. A Superficial Branch—covered by the pronator, and ascending, beyond the termination of the brachial muscle, to the anterior part of the condyle, inosculates, upon the internal brachial, with the *anastomotic*. In this course it distributes many branches to the neighbouring parts.

c. A Deep Branch—running between the sublimis and profundus to the cavity between the olecranon and flexor condyle; giving

1. A branch to the sublimis and profundus.
2. Branches to the ulnar flexor, and extensor of the carpus, and to the periosteum.
3. Inosculating Branches---uniting, in many places, above the cavity just mentioned, with branches of the *communicating ulnar*, the *anastomotic*, and the *interosseal*, contributing to form the *dorsal arch*.
4. Many branches to the joint.

D. The NUTRITIOUS ARTERY of the ULNA—running on the anterior surface of the bone, near the origin of the profundus.

E. The COMMON INTEROSSEAL—rising at the higher extremity of the profundus—running on the interosseous ligament, between the flexor pollicis and profundus, to the pronator quadratus, and there dividing into the two arteries *k* and *l*, gives, in this course,

a. Branches to the radical flexor of the carpus, pronator rotundus, profundus, and sublimis.

b. A Small Perforant Branch—to the supinator brevis and capsule.

c. A branch to the flexor of the thumb and tendon of the biceps.

d. A Nutritious Branch of the Ulna—entering the middle surface of this bone.

e. The *Highest Posterior Interosseal Perforant*—rising, sometimes wholly, from the ulnar, as at B—sometimes double, when its largest division communicates, by its recurrent twigs, with the former; but sends off, at the same time, a large descending branch, running with the extensor of the little finger, by which it is covered, as far the extremity of the fore-arm, where

at last it inosculates with the posterior *dorso-interosseal*. It gives

1. Reflex branches to the supinator brevis and the origin of the common extensor.
2. Branches ramified on the radial and ulnar extensors of the carpus.
3. Branches to the extensors of the thumb, the common extensor, and abductor.
4. Many branches---uniting with the *inferior perforants*.

f. A large branch to the profundus, winding extensively downwards on this muscle.

g. The *Nutritious Artery of the Radius.*

h. Many branches—going, in the descent of the trunk, to the profundus and the flexor of the thumb.

i. *Small Interosseal Perforants*—from four to seven in number; rising separately from the trunk; perforating, in different places, the interosseous ligament; and passing into the common extensor, supinator brevis, ulnar extensor of the carpus, the extensors of the thumb, fore-finger, little-finger, and periosteum, they all enter into various inosculations with one another; and the superior are larger than the inferior.

k. The *Posterior Dorso-Interosseal*—the larger branch of the divided artery; rising at the inferior margin of the pronator quadratus; and, having passed over the interosseous space, branching out at the posterior extremity of the ulna and wrist, divides into three branches—and gives

1. A branch to the pronator quadratus in its passage.
2. Branches to the tendons of the radial extensors and periosteum; inosculating with inferior branches of the radial artery.
3. A branch, anastomosing with the *highest interosseal perforant.*
4. The *Ulnar* Branch---the first artery of the divided trunk, bending to the posterior surface of the ulna, along with the tendon of the ulnar extensor; and inosculating with the perforating branches of the radial artery, the *middle branch,* and the *dorsal of the hand.*

5. The *Middle* Branch---larger than the rest; sinking under the ligament of the carpus to the tendons, the ligaments, and skin; forming a plexus with the perforating branches, the *dorso-carpal*, and its fellows.
6. The *Radial* Branch---accompanying the second tendon of the radial extensor, and inosculating with the preceding twig under the ligaments, as also with the first metacarpal branch of the *dorso-carpal*, and the *radial perforants*. These three, in conjunction with the *dorso-carpal* and *dorsal* of the *hand*, form a beautiful plexus around the carpus.

l. The *Vola-interosseal*—the other branch of the trunk covered by the pronator, running to the naked ligaments of the carpus, where, after supplying with many twigs the ulna, radius, and the articulation of the wrist, it forms a vascular plexus with the recurrent branches of the *deep volar arch*. In this course it forms other minute inosculations with the *radial* and *ulnar*.

F. Many BRANCHES—rising from the descending trunk; irregular in number and situation, and going to the long flexor of the thumb, the radial nerve, the radial and ulnar flexors, the palmaris, sublimis, profundus, and skin.

G. The DORSAL OF THE HAND—rising at the lower side of the ulna, near the pronator quadratus, at the distance of an inch from the pisiform bone; winding, under the ulnar flexor, to the back of the hand, and proceeding to the *ulnar* side of the little finger. From this are sent

a. A branch to the pronator quadratus, inosculating with a twig of the *radial*.

b. A branch to the ulnar extensor, and anastomosing, beyond the ulna, with the *ulnar* branch of the *dorso-interosseal*.

c. Branches to the articulation of the radius with the ulna, to the junction of the pisiform bone with the

cuneiform, and of the unciform with the metacarpal bone.

d. Branches to the nearest dorsal tendons.

e. Branches, inosculating on the back of the hand with the *perforants* and the third *metacarpal*; winding externally round the articulation of the hand and ulna.

f. The *Dorso-ulnar of the Little Finger*—terminating in the first phalanx, as it unites with the *volar branch* of the same finger. It is often, however, expended much sooner about the carpus.

H. A BRANCH, distributed extensively above these to the flexor tendons.

I. BRANCHES to the pisiform bone, the palmaris brevis, and the internal ligament of the carpus. These rise from the trunk, as it proceeds between the pisiform bone, and the carpal ligament, to the hand.

K. BRANCHES to the abductor of the little finger, its flexor, adductor, and palmaris brevis, communicating with the *dorso-ulnar* of the same finger.

L. The ULNAR PROFUNDA, or DEEP ULNAR BRANCH of the HAND—rising at the inferior margin of the carpal ligament; concealed between the abductor and flexor of the little finger; and proceeding to the *deep volar arch*, gives

a. Branches to the skin, palmaris brevis, and adjacent muscles.

b. Lesser Deep Branches—inosculating with the fifth inferior and the third *superior radial* or *volar perforants.*

c. A *Deep Circumflex* Branch—uniting with the radial artery, and forming under the tendons, the *deep volar arch.* Even when double, it exhibits a continuation of the trunk, and supports a communication between the two arches.

M. The VOLA-ULNAR of the LITTLE FINGER—rising near the former, and having distributed branches to the metacarpal, adductor, abductor, and the fourth lumbrical, and others communicating with the *ulnar profunda* and the fifth inferior *volar perforant,* runs to the other extremity of the fifth metacarpal bone, where it inosculates with the *dorso-ulnar* of the little finger.

N. The FIRST VOLA-DIGITAL—rising near the fifth finger, from the trunk as it bends transversely above the flexor tendons, where the superficial arch is formed, divides, at the root of the fingers, into the *digito-radial* of the little finger, and the *digito-ulnar* of the ring finger. Each of these runs tortuously along the sides of the fingers, as far as the apex. This *digital* likewise gives

a. Branches to the third and fourth lumbricals and the tendons of the flexors.

b. A branch, communicating with an *inferior volar perforant* at the bifurcation

c. A branch, forming a small arch upon the points of the fingers with the *volar artery* of the opposite side.

d. Many cutaneous branches to the *dorsal* and *volar* or concave and convex surfaces of the joints of the fingers.

e. A branch, reflected to the back of the fingers, round the root of the nails.

O. The SECOND VOLA-DIGITAL—divided into the *digito-radial* of the ring finger, and the *digito-ulnar* of the middle finger. From this proceed,

a. Two branches to the third and fourth lumbricals, inosculating with the *inferior perforants* of the *deep arch.*

b. Branches similar to those of N.

P. The THIRD VOLA-DIGITAL—divided into the *digito-radial* of the middle, and the *digito-ulnar* of the fore finger. The last of which inosculates, on the concave surface, with the *digito-radial* of the fore finger. It gives

a. Branches to the first and second lumbricals.

b. Branches, inosculating with the *deep arch* and its *perforants.*

c. Branches similar to those of N.

Q. BRANCHES to the first lumbricals, the abductor, adductor, and flexor of the thumb, the tendons of the flexors, and the skin.

R. A LARGE ANASTOMOTIC BRANCH—uniting with the radial artery, near the superior margin of the adductor of the thumb. From this inosculation a trunk is formed, which gives out the *vola-radial* of the fore finger, and the *vola-ulnar* of the thumb, or sometimes the *vola-ulnar* only.

S. MANY MINUTE BRANCHES — issuing from the concave surface of the arch, and ramified upon the tendons; afterwards sinking deeper to the wrist, inosculating with many twigs of the *vola-interosseal.*

Thus do all the *digital branches* receive, at the commencement of the bifurcation, the *volar perforants* and the *metacarpals* from the *deep arch* and the *dorso-carpal*; but as they advance, distribute twigs both to the sheaths and tendons of the extensors. The largest of these inoscu-

lates upon the back of the finger, at the second joint, with its fellow of the opposite side. Near the nail they form the *small dorsal,* and at the apex the *small volar arch* of the fingers.

THE RADIAL ARTERY—the smallest of the two branches which proceed from the division of the HUMERAL. It runs down, in a straight line, upon the surface of the pronator, and gradually inclines towards the radius, between the long supinator and radial flexor, resting on the flexor of the thumb. At the lower extremity of the radius, where it is easily felt between the styliform process and the trapezium, on the back of the hand, it bends under the abductor and extensor of the thumb, near the first radial extensor; then penetrating the abductor or semi-interosseous of the fore finger, between the metacarpal bone of the fore finger and thumb, bends, while there concealed, to the palm, between the fibres of the adductor pollicis, and forms, in the hollow of the hand, under the flexors, and above the interosseous muscles, the *deep volar arch,* in which it terminates.

A. A BRANCH, dividing upwards and downwards, to the supinator longus and the radial extensor; sometimes inosculating with the small *humeral profunda.*

B. The RADIAL RECURRENT—reflected round the tendon of the biceps, to the external condyle; concealed between the long supinator, the short radial extensor, and internal bracial, where it

forms, like the *ulnar recurrent*, important inosculations, and gives

a. Branches to the pronator rotundus, short supinator, and radial extensors; which, in their descent, inosculate with other *recurrent ramuli*.

b. Branches proceeding, at various places from the trunk, to the radial extensors, long supinator, the extensor of the fingers, the ulnar extensor, and skin. Of these, the branches reflected to the extensors inosculate with the *highest posterior interosseal perforant*.

c. The *superficial anastomotic* branch—inosculating on the surface of the internal brachial with the *small humeral profunda*, and the *profunda radial* of the arm, as they wind near the spine of the condyle, under the superior fleshy part of the supinator and the radial extensor.

d. A branch sunk in the internal brachial, and forming round the joint on the capsule and periosteum, the *anterior arch*, with the large anastomotic branch of the *humeral*.

e. Branches to the articular ligaments.

f. The *deep anastomotic* branch—running extensively between the long supinator and the bone, or betwixt the radial extensor and triceps, to the posterior surface of the external condyle, where it inosculates with a branch of the *small profunda*, and the *profunda-radial* of the arm.

g. Branches spreading, near the termination of the trunk, on the skin of the arm.

C. Many branches—as the trunk runs superficially on the pronator rotundus, to the radial extensors, the two supinators, the pronator rotundus, and radial flexor. Some of these usually inosculate with twigs of the *common interrosseal*.

D. Branches—rising from the artery as it leans on

the radius, sinking into the sublimis, flexor of the thumb, radial flexor, and palmaris longus, and in many places inosculating with branches of the *ulnar* going to the same muscles.

E. A BRANCH to the pronator qurdratus, inosculating with twigs of the *vola-interosseal.*

F. BRANCHES to the tendons of the supinator, radial, abductor of the thumb, and bone of the radius; uniting with the *dorso-interosseal.*

G. BRANCHES running on the hand to the tentons of the flexors.

H. The SUPERFICIAL VOLAR—rising at the inferior extremity of the radius, where the trunk begins to bend to the back of the hand, and proceeding near the os trapezium, beyond the tendon of the radial flexor, runs to the palm, under the skin, and above the short abductor of the thumb. This artery is sometimes large, and presents many varieties; and at other times is so small as not to pass the abductor. If large, it commonly sends

a. Many branches—issuing, at various places, to the surface of the carpal ligament, the tendon of the radial, the abductor, and opponens pollicis.

b. A branch, inosculating with the *dorso-radial* of the thumb.

c. An *anastomotic* branch—uniting with the ulnar artery, near the termination of the flexor of the thumb, to which it gives twigs. It is sometimes wanting.

d. Branches to the first and second lumbricals, inosculating with twigs of the *ulnar.*

e. The *vola-ulnar of the thumb*—rising sometimes from the trunk (as below); at other times exhibiting, beyond the adductor, a continuation of the trunk on

the ulnar side of the thumb, where it inosculates, near the apex and articulation, with the *vola radial.*

I. A BRANCH—ramified on the ligament of the carpus, the bone of the radius, and the flexor or tendons.

K. BRANCHES to the tendons of the abductor and radials, inosculating with the *dorso-radial* of the fore finger.

L. BRANCHES to the neighbouring bones and their articulations.

M. A BRANCH to the abductor brevis, and opponens pollicis.

N. The DORSO-RADIAL of the THUMB—rises from the trunk as it bends to the back of the hand, near the os trapezium, and accompanies the metacarpal bone of the thumb, running along the external insertion of the opponens.

a. Branches to the tendons of the extensors, abductor and opponents of the thumb, forming, in many places above its metacarpal joint, a vascular arch with the *pollicar*, or principal artery of the thumb.

b. A branch—uniting at the last phalanx of the thumb with the *vola-radial.*

O. The DORSO-ULNAR of the THUMB—rising near the os trapezoides, under the tendons of the abductor and long extensor.

a. Branches to the abductor and articulation of the fore finger or index, inosculating with the *dorsa-radial* of the index.

b. A branch, terminating in the first phalanx of the thumb, and inosculating with the *vola-ulnar* and the *dorsa-radial.*

P. THE DORSO-CARPAL—issues from the trunk,

near the tendons of the radial, and proceeds transversely above the carpus, and under the tendons of the extensors, to the ulnar side of the wrist, where it forms an extensive plexus with the branches of the *dorso-interosseal*, and completes the *dorso-carpal arch* with the *dorsal* of the hand: At the same time sends off

a. The *First Metacarpal*, or *Dorso-interosseal*—descending beyond the carpus, upon the surface of the first interosseous muscle, between the fore and middle fingers; and inosculates with the third *vola-digital* at its bifurcation. In which course it gives

1. Branches communicating, in two places, with the *superior perforant*.
2. Branches, distributed to the interosseous muscles, the joint, and extensors of the index.

b. Branches to the bones of the carpus and joint, inosculating with the branches of the *dorso-interosseal*.

c. The *Second Metacarpal*, *Dorso-interosseal*—running in the interosseus space to the roots of the third and fourth fingers.

1. Double branches, inosculating with the *superior volar perforants*.
2. Branches communicating with the *first* and *thi d* and distributing twigs, similar to the former, at *a*.

d. The *Third Metacarpal*, or *Dorso-interosseal*—running, like the last, in the fourth interval of the fingers, and forming similar inosculations with the adjoining arteries. Sometimes one or other of the *metacarpals* is produced from the *perforants*.

Q. The DORSO-RADIAL, or LARGE, or RADIAL INTEROSSEAL of the INDEX—rising between the first and second metacarpal bones, while the trunk penetrates the inferior margin of the abductor or semi-interosseus; and, following the

course of the interosseous, inosculates on the index with the *volar* artery of the same finger.

- *a*. Branches to the abductor, articulation, and extensor tendons of the index.
- *b*. Branches inosculating with the *dorsal* of the thumb.

R. The POLLICAR, OR PRINCIPAL ARTERY of the THUMB—rising from the radial trunk, where it sinks among the muscles to the palm of the hand between two metacarpal bones; and, dividing into two branches, runs to the volar side of the thumb, between its abductor and adductor muscles. It generally gives

- *a*. Many branches to the back of the metacarpal bone and adductor of the thumb.
- *b*. A Deep Branch to the *radial* and *ulnar* sesamoid bones, distributed to the back of the thumb and the neighbouring muscles.
- *c*. Branches going down to the hollow of the carpus.
- *d*. Anastomotic branches, interwoven with one or other of the arteries of the thumb.
- *e*. The *Digito, or vola-radial of the Index*—running to the radial side of the fore finger, and uniting beyond the adductor of the thumb, with the interosseal of the index, or a superficial branch of the ulnar.
- *f*. The *Digito*, or *Vola-radial of the Thumb*—the outer branch of the trunk, as it divides at the lower extremity of the metacarpus, sends many twigs to the back of the thumb from its radial side, and inosculates upon its apex with
- *g*. The *Digito*, or *Vola-ulnar of the Thumb*—the internal branch of the same trunk, rising often from the superficial *vola-radial*, reaching to the thumb, and inosculating with the *superficial* arch. It gives
  1. Branches to the adductor, flexor brevis, &c.
  2. Branches to the sesamoid bones and the thumb, as above.

S. The SUPERIOR VOLAR PERFORANTS—three in number, proceeding from the concave margin of the *deep volar arch* as it rests on the interosseous muscles; and, penetrating near the superior extremity of the metacarpal bones, at the back of the hand, they produce, as it were, *middle metacarpals*, interwoven with the branches of the *dorsor carpal.*

T. The INFERIOR VOLAR PERFORANTS, or VOLAR-INTEROSSEALS—rising, six or seven in number, from the convex margin of the deep arch. They occupy the metacarpal interstices; and, winding round the radial and ulnar sides of each bone, inosculate, at the roots of the fingers, with the *mecarpal* and *vola-digital* branches.

U. Two or THREE RECURRENT BRANCHES to the carpus, anastomosing with ramuli of the *vola-interosseal*, and with some twigs of the *radial* and *ulnar.*

V. A BRANCH, completing the *deep arch*, by inosculating, near the little finger, with the *ulnar profunda* of the hand.

We must here stop in the description of the Arteries of the hand, which exhibit almost an endless variety in their distribution.

SECOND SUBDIVISION.

BRANCHES FROM THE DESCENDING AORTA.

IT appears, from the general description of the Aorta, that, after the formation of the arch, it bends gradually behind the lungs to the left side of the vertebral column; and, lying close upon this column, penetrates, in a straight line, behind the pleura, through the cavity of the thorax, to the muscular crura of the diaphragm, directing its course in the abdomen to the inferior lumbar vertebræ.

Anatomists have therefore properly divided the DESCENDING AORTA into the THORACIC and VENTRAL; whose limits are defined by the diaphragm, which allows, by the separation of its crura, a convenient passage for the descending trunk.

DISTRIBUTION OF THE THORACIC AORTA.

Through its whole descent, the THORACIC AORTA inclines to the left; though near the lesser or inferior diaphragm it seems gradually to approach the middle of the vertebræ. The numerous branches which it sends out, though not large, are yet worthy of notice. These are,

I. The SUPERIOR and POSTERIOR PERICARDIAC ARTERY—rising from the concave surface of the arch; most commonly, however, from the *subclavian* or *internal mammary*—which see.

II. The COMMON BRONCHIAL ARTERY—rising from the fore part of the thoracic aorta, and immediately dividing into the right and left *bronchial* arteries. Both of these, as they go down the anterior part of the trachea, are ramified on the bronchia, their glands, and vessels: the *left* on the posterior surface of the lungs; and the *right* on the œsophagus also. Sometimes this artery is wholly wanting, or supplies the functions of the following arteries.

III. The RIGHT BRONCHIAL ARTERY—rising sometimes from the aorta; at other times from the *superior*, of the *inferior intercostals*; sending its twigs, both before and behind the right bronchus, to the air-vessels and adjoining glands; and giving others to the neighbouring lobes of the lungs, the pleura, the posterior part of the pericardium, the pulmonary sinus, and, finally, to the œsophagus.

IV. The LEFT or SUPERIOR BRONCHIAL—rising transversely to the left *bronchus*, or left division of the trachea, and giving branches similar to the former.

V. The INFERIOR BRONCHIAL—issuing from the aorta at the fifth vertebra, and accompanying the bronchi, in the course of the pulmonary vein, to the internal parts of the lungs; distributing twigs similar to the former *bronchial*.

N. B. Although the BRONCHIAL ARTERIES deserve our attention from their inosculations in the substance of the lungs with the small branches of the pulmonary artery; yet, like other smaller vessels, they exhibit new varieties in almost every *subject*.

VI. OESOPHAGEAL ARTERIES—five or six in number—slender—issuing, at different places, from the trunk, under the *bronchials*, or sometimes from the *bronchials* themselves. They wind on the surface of the œsophagus, running afterwards to the posterior mediastinum and the pericardium. Of these, the largest enters the abdomen with the œsophagus, and generally inosculates with the *coronary œsophageal*, or or ascending coronary branch of the *cœliac* and the *phrenic* arteries.

VII. The INFERIOR, or AORTIC INTERCOSTALS—from eight or ten in number—rise from the posterior and lateral sides of the trunk, and, bending to the interstices of the ribs, run along their inferior margins. As the branches of the right side must pass over the bodies of the vertebræ, they are longer than those of the left. The four or six superior ones are smaller, and ascend a little; while the inferior proceed transversely. The *first superior*, rising at the fourth vertebra, and running in the third or fourth costal interstice, inosculates with the *superior intercostal* of the subclavian. The last, rising behind the crura of the diaphragm, passes over the quadratus lumborum; and, following the margin of the last rib, is distributed to the apo-

neurosis of the transverse muscle of the abdomen. They all send,

A. *Three Branches*—running, near the heads of the ribs, to the spinal cavity: the *first* entering the bone; the *second*, the dura mater; and the *third*, where the costal nerve comes out, entering the spinal marrow.

B. Deep Dorso-muscular Branches—sent to the dorsal muscles; and forming a plexus on the back.

N.B. The preceding twigs sometimes unite into one trunk.

C. A number of branches to the intercostal muscles; and, after penetrating these, distributed to the serratus anticus, pectoralis, latissimus, and external oblique.

D. The *Superior Costal* Branch—the smaller division of the trunk—winding from the angle of the rib to its superior margin, and sometimes forming, as its runs along, the *superior ring* or inosculation.

E. The *Inferior Costal* Branch—exhibiting a continuation of the trunk; uniting above with the *thoracics* and *internal mammary;* below, on the forepart of the abdomen, with the *epigastic* and *lumbar* branches. It forms the *principal ring* with the *mammary;* and in its course gives every where twigs to the neighbouring parts.

DISTRIBUTION OF THE VENTRAL AORTA.

The VENTRAL, OR ABDOMINAL AORTA, is the lowest part of the common trunk. It passes from the thorax, through the inferior muscle of the diaphragm, to the right side of the œsophagus, in a straight direction, inclining rather to the left; and proceeds gradually through the abdomen, upon the surface of the vertebral column, to the fifth lumbar vertebra, or to the thick ligament

connecting the fourth and fifth. The inner or long crura of the diaphragm, variously interwoven behind the œsophagus, separate anteriorly on the aorta, allowing a passage, through which it descends resting posteriorly on the vertebral column. This passage is considerably larger than the trunk, loose cellular substance, connecting the pleura and peritoneum, being interposed. The aorta at this place is separated from the vena cava by the left lobe of the liver, a part of the diaphragm, and a large quantity of cellular substance; but in the space between the kidnies and the liver, these two vessels approach so near, that the right margin of the artery is partly covered by the vein that afterwards sends some of its branches anteriorly across.

The Ventral Aorta is divided at the vertebra, mentioned above, into two branches of equal size, forming an acute angle as they run towards the brim of the pelvis. These, anatomists have called *Iliacæ Communes*, or Common Iliacs. The branches of the ventral aorta are best described in the order in which they occur.

I. The PHRENIC ARTERY—*Right* and *Left*—very irregular in origin and division. Sometimes a single trunk, rising above the *cœliac*, divides into the *right* and *left phrenic:* sometimes, again, and indeed most frequently, the *right* rises from the *cœliac*, and the *left* from the aorta; while, at other times, they have been observed rising together, both from the *cœliac*, or both from the aorta.

Sometimes the single trunk, or *common phrenic*, being larger than usual, constitutes the fourth branch of the *cœliac;* and then forms the *superior coronary* branch of the stomach. There are sometimes three or four phrenic arteries, which, as soon as they arise, bend obliquely outwards, before the erura of the diaphragm, to the inferior margin of its tendinous alæ; and, while they here wind tortuously under its fleshy fibres, distribute various twigs, upwards, outwards, inwards, and downwards. Bending at last to the external margin of the tendon, and, passing between the muscular layers, they run forwards, and inosculate, upon the costal muscles, with the *thoracic* vessels and the artery of the opposite side. At the bend of the artery, however, they send a larger branch to the posterior and inferior portion of the diaphragm as it rises from the ribs. Besides the branches of the diaphragmatic tendon and muscle, the following likewise merit attention:

A. Branches going to the two sides of the renal capsules, and adipose substance lying on the kidnies. See a description of these arteries below.

B. Branches—uniting, after penetrating the diaphragm, with the accompanying branch of the phrenic nerve, and the other *phrenics* rising from the *mammary.*

C. Branches—some passing on the right ride to the pancreas, liver, and vena cava; others accompanying the vena cava to the pericardium, the posterior surface of the liver, and its suspensory ligament; inosculating, in many places, with the hepatic arteries. Upon the left, they run to the left lobe of the liver, the ligament of the spleen, the œsophagus, and cardia.

N.B. The diaphragm sometimes receives wandering branches from the *cœliac*, *inferior intercostals*, the *capsulars*, and the *lumbars*, particularly from the *second lumbar*.

II. The COELIAC ARTERY—short; but of large diameter—rising between the crura of the diaphragm, above the eleventh dorsal vertebra, from the anterior part of the aorta, and at the superior margin of the pancreas, between the papillary lobule, or lobule of Spigelius, and the left side of the lesser arch of the stomach. It then descends, in a tortuous manner, forwards and to the right, and, running about the third of an inch, ultimately separates into three branches, in such a manner, that the two on the right seem to arise from a common base; while the left is more distinct at its origin. These are,

A. The *Superior Coronary*, or *Great Left Gastric*, or *Superior* or *Left Gastro-hepatic*—smaller than the other branches, if reflected only to the stomach; but almost equal in size to the *splenic*, if, as sometimes happens, it sends a branch also to the liver. It appears sometimes to issue from the *splenic*; ascends to the left, and forwards to the cardia and lesser arch of the stomach; then bending downwards, and to the right, reaches the margin of the stomach, where it distributes extensively its circuitous branches, forming a corona, to both sides of the stomach. Of these, the principal are,

a. A *Superior* Branch---running transversely upon the anterior surface to the greater arch of the stomach, and that place where the œsophagus is dilated into a sac.

1. An Ascending Branch---passing up with the œsophagus into the thorax, and inosculating with the *inferior œsophageal*.

2. Branches to the diaphragm, the lesser omentum, the glands, and left renal capsule, dividing sometimes into more, and sometimes into fewer, ramuli.

3. A Transverse Branch---traversing the left extremity of the stomach, and running, with descending branches, to its greater arch, where it inosculates with some branches of the *vasa brevia*.

b. The *Inferior* or *Right Coronary*---sometimes double, descending, by the lesser arch of the stomach, towards the pylorus; and in its course giving

1. Many Anterior and Posterior *Gastric* Branches---winding between the coats of the stomach, and at last inosculating with the *gastro-epiploics*.

2. The *Superior Pyloric*---the last branch of the trunk---running along the superior margin of the stomach, in such a way, that its twigs are distributed partly to the stomach, and partly to the pylorus. The small artery itself disappears in the *right superior pyloric* branch of the *hepatic* artery.

c. The *Left Hepatic*. --This artery, when present, terminates the trunk. Sometimes the *gastric* after the former branches are sent off, runs immediately upwards, and to the right; and, sinking between the lesser arch of the stomach and the left lobe of the liver in the *transvsrse fossa*, is variously ramified to the left lobe, the lobule of Spigelius, the *umbilical fossa*, and the *venus duct*; at other times these branches arise from the *cœliaco-hepatic*.

B. The *Hepatic*.—This artery, which in adults is smaller than the *splenic*, but in children larger, rises from the right side of the *cœliac*, or, as sometimes happens, from the *superior mesenteric*; when, turning upwards near the outer point of the lobule of Spigelius, it is concealed by the pancreas; then proceeding forwards, upwards, and to the right, behind the right extremity of the stomach and the duodenum, it observes the same obliquity as the lesser arch; and, after running an inch, or an inch and an half, divides, below the neck of the gall-bladder, into the *right transverse* and *left ascending hepatics*; entering, at last, with the other hepatic vessels, the transverse fissure or fossa of the liver. Inclosed in the capsule of Glisson, it occupies a middle

space between the biliary ducts and the vena porta. Before its division, it sends

a. Many small pancreatic branches.

b. Minute branches to the lesser omentum and vena porta.

c. The *Duodeno-Gastric*, or *Gastro-duodenal*, or *Pancreatico-duodenal*---rising at a right angle from the trunk, and, behind the pylorus, proceeds forwards between the commencement of the duodenum and the head of the pancreas, and, without forming a connection with this gland, reaches the last curvature of the duodenum: then inclining to the larger arch of the stomach on the left, and entering the web of the omentum, it inosculates, in the middle of the great arch of the stomach, with the *left gastro epiploic*. From this are sent,

1. Small Pancreatic Branches.

2. The *Inferior Pyloric*---passing to the right, and distributing its branches, under the duodenum, to the space between the curvatures of the stomach and the first flexure of the intestine; some of which inosculate with the *superior pylorics*, and others with the *right gastro-epiploic*.

3. Small Duodenal Branches---passing from the trunk behind the commencement of the duodenum. Sometimes wanting.

4. The *Right Superior Duodenal*---sometimes double or triple, and frequently issuing from the *hepatic*. Passing the choledic duct, it winds on the posterior surface of the first transverse and descending flexion of the duodenum; when, turning to the right margin of the pancreas, and the lowest posterior part of the second flexion of the duodennm, it inosculates on the left with the *inferior mesenteric duodenal*. It sometimes winds, in a similar manner, on the posterior surface of the duodenum; and upon its anterior with the *pancreatico-duodenal*. It gives

 Branches anastomosing with the *pylorics*.

 Branches to the biliary ducts, accompanying them to the liver.

5 The *Pancreatico-duodenal*---traversing the inner curvature of the duodenum in the form of a semicircle, and sending numerous branches outwards to the perpendicular and second transverse portions of the duodenum; and inwards to the head of the pancreas; at last inosculates with the *duodenals* of the *mesenteric*.

6. The *Transverse Pancreatic*---rising, near the inferior

margin of the first flexion of the duodenum; and, passing to the left, over two-thirds of the posterior surface of the pancreas, gives everywhere twigs to the substance of the gland and mesocolon. It sometimes rises from the *mesentric*, and sometimes from the *splenic*.

7. The *Right Gastro-epiploic*, or *Right gastric*, or *Inferior Coronary*---exhibiting a continuation of the trunk as it bends to the greater arch. Passing obliquely downwards, behind the pylorus, to the posterior side of the stomach, it is connected, by means of the omentum, to the greater arch; and, traversing its margin to the left, at last disappears in the *left gastro-epiploic*. From this proceed,

The *Great Posterior Epiploic*---to the right side of the large or *gastro colic* omentum.

Small Epiploics to the same omentum and colon, inosculating, on this intestine, with the *medio-colic*.

Gastric Branches---running to each side of the stomach and inosculating with the former *gastrics*.

Numerous branches to the glands.

d. The *Superior Hepatico-Pyloric, Small Right Gastric*, or *Lesser Coronary*. According as the *hepatic* divides, sooner or later, this artery arises from its trunk, or its left branch; and, reflected, with a very acute angle to the lesser arch, there inosculates, in various places, with the *pyloric* of the *coronary* artery; and sends,

1. Branches to the biliary ducts, inosculating with the *cystic* arteries, and to the smaller *gastro-hepatic* omentum.
2. Branches to the Pyloris---communicating with the *inferior pyloric, gastro-epiploic*, and *superior duodenal*.

e. The *Left Hepatic*---the lesser branch of the divided trunk, and often wanting when the *hepatic* rises from the *coronary*. It first proceeds, with the trunk, parallel to the vena porta; then mounting over the trunk, enters the *umbilical fossa*, where it sends,

1. Branches to the substance of the liver near the venous duct, to the lobule of Spigelius, the left lobule, and lobulus anonymous.
2. Branches passing through the *umbilical fossa* to the round and suspensory ligaments, inosculating anteriorly with twigs of the *epigrastic*, and posteriorly with *phrenic* or *mammary* twigs.

f. The *Right* or *Biliary Hepatic*---covered by the biliary ducts, conceals itself in the right extremity of the *traverse fossa*, sometimes rises from the *superior mesenteric*, is sometimes double, giving rise to the

1. *Cystic* Branch---not unfrequently double---winding, upon the left side of the cystic duct, to the fundus of the gall bladder; at last exhausting itself on the substance of the liver, it sends

   Branches to the biliary ducts, uniting with those of the *duodenal.*

   Branches, winding circuitously between the coats of the gall bladder.

2. Large Branches---running deep into the right lobe and the lobulus anonymus.

C. The *Splenic.* — While this artery runs along the upper surface of the pancreas, and passes transversely to the depression of the spleen, it exhibits large and repeated flexions, upwards and downwards, bending in a circular or spiral form. Approaching the substance of the spleen, it divides into many branches, which are equally tortuous; and of those that sink into the spleen, some smaller ones return through its substance to the diaphragm or stomach. Its most remarkable branches are,

a. The *Great Pancreatic*---irregular both in size and direction. The whole branch is sometimes covered by the pancreas; and, passing to the right extremity of this gland, supplies it with twigs; sending others, at times, to the adjoining duodenum and mesocolon. If the trunk divides, another branch, bending to the left, supplies the place of the *transverse pancreatic*, It inosculates with the *pylorics* and *duodenals.*

b. *Small Paecreatics*---descending from the *splenic*, in great numbers, through its whole extent.

c. *Posterior Grastics*---two or four in number--sometimes wanting---rising from the middle of the trunk as it passes to the spleen, and ascending with the omentum to the posterior surface of the large extremity of the siomach.

d. The *Left Gastro epiploic*, or *Left Gastric*---often double---rising near the commencement or left extremity of the pancreas, where the trunk begins to divide; bends downwards, and to the right, with its two

branches to the fundus and larger arch of the stomach; and, like the *right gastric*, with which it inosculates, follows the large curvature of the stomach.

1. Pancreatic Branches.
2. *Large Epiploics*--three or four in number; one of which is usually larger than the rest, but all distributed to the omentum and colon.
3. *Gastric* Branches- inosculating with the *coronaries* on the surface of the stomach.

e. The *Vasa Brevia*, or Short Branches---three or four in number---issue from the trunk as it reaches the depression of the spleen; and distribute their ramuli to the fundus of the stomach, where they spread, in various directions, on it surface, and inosculate with many of the neighbouring branches.

N. B. A branch is sometimes sent from the *splenic* to the transverse colon, anastomosing with the *medio-colic*.

III. The SUPERIOR MESENTERIC—the largest of the abdominal or ventral branches—rising between the crura of the diaphragm, three or four lines below the *cœliac*, from the anterior part of the aorta, and under the lower edge of the pancreas; proceeds between this gland and the inferior transverse flexion of the duodenum. Passing over this portion of the intestine, it bends to the right under the mesocolon; where, received near the vertebræ into the folds of the mysentery, it first inclines to the left, and then to the right, where the whole artery, advancing to the right ileum, assumes the form of the Roman S, with the concave side of its large curvature looking to the right. After giving off smaller branches, the trunk sends from its right side only two branches to the large intestines; but from the left it gives a

greater number of branches to the small intestines. These are,

A. *Posterior Pancreatics*—numerous—penetrating the right and left sides of the pancreas, and inosculating with the *pancreatico-duodenal, transverse pancreatic*, and the *splenico-pancreatics*. Some of these pass through the mesocolon to the colon itself.

B. The *left inferior duodenal*—two or three of them—rising from the left side of the trunk, and stretching to the inferior and left curvature of the intestine. While some twigs are reflected, upwards and backwards, in the form of arches, the rest inosculate variously with the *superior duodenals*, the *pancreatico-duodenal* before this gland, and with their fellows. These branches, however, are very irregular.

C. The *superior* or *medio-colic*—rises sometimes above the *duodenal* branches; but generally below them, under the duplicature of the mesocolon, and runs along the transverse mesocolon from the left, forwards, and to the right, to the right colon and adjoining part of the transverse colon. It sometimes rises double; but more frequently, after running a short way upon the mesocolon, divides into two branches, viz.

a. The *Transverse Colic*---passing, in the duplicature, along the middle of the mesocolon, to the concave side of the transverse colon, after having first divided, sooner or later, about three inches from the edge of the intestine, into two diverging branches, viz.

1. The *Right Anastomotic* Branch---bending to the right side of the transverse colon, and forming an arch with the ascending anastomotic branch of the *right colic*. From the convexity of this arch, as from that of all the other arches formed on the concave side of the large intestines, many parallel branches rise, about two inches in length, which, as they approach the intestine, divide into twigs, entering the concave arch of the tube, and circling

round on the opposite sides, till they meet and inosculate at its convexity. These minute twigs inosculate freely with the small *epiploics* of the cœliac artery, and are ramified similarly, both on the large and small intestines, although on the former they be less numerous.

2. The *Left Anastomotic* Branch---accompanying the left part of the transverse colon with a similar and parallel arch, and at last inosculating, freely and elegantly, with the large anastomotic branch of the *left colic*, proceeding from the *inferior mesenteric*. Thus is formed the *great mesenteric arch*. Intestinal branches, rising from the arch, are similar to the former.

b. The *Superior Right Colic*---sometimes rising, by a separate trunk, from the *mesenteric*; proceeds transversely and to the right, in the duplicature of the mesocolon, to the *hepatic flexure* of the colon; and where it approaches the intestine, gives,

1. A Large Ascending *Anastomotic* Branch---bending to the middle of the colon; forming an arch with the right anastomotic branch of the *transverse colic*.
2. Two or three branches, descending a short way to the right colon; forming sometimes together smaller arches.
3. The Last Descending Branch--inosculating with the curved ascending branch of the *ileo-colic*, and forming here another new and larger arch.

D. The *Ileo-colic*.—This artery rises single from the right side of the trunk, about an inch or two below the last, and below the transverse mesocolon. It afterwards proceeds behind the right mesocolon, and descends beyond the psoas muscle to the junction of the ileum and cœcum. Its principal branches are,

a. A Curved Ascending Branch---distributing twigs to the right colon, and uniting with the descending branch of the *superior right colic*.

b. *Inferior Right Colics*---rising sometimes from the former, and running, with a double branch, to the adjoining intestine.

c. A *Cœcal* Branch---larger than the former, and directing its course, with its trunk the *ileo-colic*, to the cœcum. It gives out,

1. The *Anterior Cœcal*---passing along the anterior fold

between the ileum and cæcum, and distributing its branches upon the anterior part of the cæcum.

2. The *Posterior Cæcal*---running to the posterior surface of the cæcum, giving branches to the root of the vermiform process, and inosculating, near the right of the cæcum, with a former artery and with the *appendicular*.
3. The *Appendicular*---reaching, behind the cæcum, to the small mesentery of the vermiform process; and, as it runs along this, giving straight and short twigs to the process.
4. An *Iliac* Branch---winding to the left, and forming an arch, near the ileum, with the extremity of the mesenteric trunk, from which the ileum receives new branches.

Branches, varying in number, from twelve to twenty, rise close to one another from the left convex side of the superior mesenteric, distributing ramuli to the ileum and jejunum. Of these, the superior are short and slender; the middle long and thick; the inferior shortest; and the last branch of all, as observed above, inosculates with the *ileo-colic*. Running near and parallel to each other, they first proceed transversely; then, rising between the layers of the mesentery, divide into smaller branches, which so diverge that in whatever direction they go, they are soon after divided into two. These branches, as they meet, form various arches, from whose convex margin new parallel branches arise; which again soon dividing, inosculate with the adjacent branches, forming smaller and more numerous arches. From the convexity of these arches other branches arise, forming a third series of arches; and where the branches are longest, even a fourth or fifth series; till the last branches, near the intestines, dividing into anterior and posterior, encircle these viscera, and, gradually penetrating their coats, form most beautiful arborescent ramifications on their cellular membrane. These arches, by means of their twigs, not only form various inosculations among themselves, but also with the arborescent ramifica-

tions of the two surfaces. The inner intestinal coat is so covered by these branches and the veins, as to give it the appearance of being wholly vascular. The trunks of these *arborescents* lie on the roots of the *valvulæ*. The arches are polygons; and the first series larger than the rest. The lymphatic glands, and coats of the vessels, are surrounded with numerous and various twigs as variously distributed.

N. B. The more slender branches of the *mesenteric* generally inosculate freely with the *spermatic* arteries, near the duodenum and commencement of the small intestines, and with the *capsular* and *adipose* branches. Singular, likewise, is that inosculation which the *mesenteric* forms with the *epigastric* in the fœtus.

IV. The INFERIOR MESENTERIC, or LEFT COLIC.—This artery rises, between the *renal* and *common iliacs*, from the anterior and left side of the aorta; descends behind the peritoneum to the left side of the trunk; and having reached that place where the aorta divides into two remarkable crura forming the *iliacs*, sends off a large branch; and, after passing the iliac artery, sinks behind the rectum into the pelvis. As it here rises forward and to the right, it enters the duplicature of the mesorectum, and accompanies the intestine as far as its internal sphincter. It sends out,

A. One or two branches, near its origin, distributed to the lumbar glands and the peritoneum, and inosculating, upon the left side, with some branches of the *spermatics*.

B. The *Left Colic*—a thick, but very short artery; often about two lines in length, and issuing from the place just mentioned, runs in the duplicature of the left mesocolon to the left side, and divides into three widely diverging branches, viz.

a. The *Ascending* Branch---rising to the left angle of the transverse mesocolon; and reaching this, divides into,

1. A *Large Anastomotic* Branch---bending to the right, and forming the *large mesenteric arch* with the left anastomosing branch of the *transverse colic*. When this branch is large, it contributes more to the formation of the arch than the *transverse colic.*
2. A *Small* Branch---sent transversely, above the kidney, to the *splenic flexure* of the colon, and left colon; afterwards uniting with the following branch, by means of the arch, which gives out many straight twigs to the intestines.

b. The *Transverse* Branch---running, often double or triple, to the left colon; but first dividing, and sending a branch, which inosculates upwards with the *ascending*, and downwards with the *descending* branch.

c. The *Descending* Branch---running to the last portion of the left colon and its *iliac flexure;* varies in the size and number of its branches, according as the curvature of the intestine is greater or less. It is often divided into three branches, which form *anastomotic arches* among themselves, and with the former.

N. B. The *Left Colic* gives out also branches, forming a plexus with the *lumbar* branches, and with smaller twigs of the *spermatics.*

C. The *Internal Hæmorrhoidal.*—This name is given to the trunk when it reaches and runs along the posterior part of the rectum. It gives out

a. One or two branches to the lower part of the colon.

b. Branches encircling the rectum, and uniting anteriorly, without forming an intermediate arch.

c. Branches which, with the *middle hæmorrhoidal,* the lowest *vesical,* or *uterine branch* of the *hypogastric,* inosculate freely at the inferior part of the intestine which this artery does not reach.

V. Capsular, or atrabiliary—Right and Left. These are distinct small arteries; which, though never wanting, as they distribute many branches to the capsular gland, yet, in almost every individual, they present irregularities in number, size, or direction. They do not, like the vein,

issue from one common trunk, but from various branches, coming together near the seat of the gland; and may therefore be divided into three classes.

A. The *Superior Capsular* Branches—from two to four in number—rising from the *inferior phrenics*, from their common trunk, or from the *transverse* branch; spread variously upon both sides of the gland, and supply the fat, which surrounds the kidnies, with various twigs.

B. The *Middle Capsulars*—very often double—sent from the aorta, between the *phrenics* and *superior mesenteric*. These small branches, proceeding transversely to the gland, soon divide; and give

a. Anterior and posterior branches to the gland.
b. Small *Phrenic* and *Adipose* branches.
c. Branches, running, upon the right side, to the nearest part of the liver, the vena cava, the coverings of the duodenum, and the right mesocolon; and upon the left, to the surface of the spleen and adjoining mesocolon. They frequently unite with the arteries belonging to those viscera.

C. The *Inferior Capsulars*—two or three in number—rising from the superior edge of the renal artery. They ascend outwards; and, after reaching the gland, if they be of considerable size, communicate wandering but numerous branches to the neighbouring viscera, the renal fat, and the adjacent arteries, particularly the *spermatics*.

VI. The RENAL, OR EMULGENT ARTERY—Right and Left.—It is unnecessary to enumerate the varieties which anatomists have observed as to the number, origin, and magnitude of this artery. It generally rises single from the side of the aorta, between the superior and inferior mesenteric arteries, from which it descends transversely at less than a right angle. The *left*, which is rather

shorter than the *right*, and more posterior in its origin, turns, near the kidney, over its concomitant vein; while the *right*, which is longer, is covered by its concomitant vein. Approaching the renal depression, it divides into two or four branches; which, sinking separately before and behind the pelvis of the kidney, are again divided, and distribute their spreading branches to the papillary cones. These, as they encircle the convex margin of the papillæ, form arches with the adjoining branches, and seem to separate the cortical from the tubular substance. From the convex and concave margin of each arch rise innumerable small arteries; of which the former encircle the cortex, and with some of their branches pass through its substance, and disappear on the fat: while the rest are chiefly dispersed and exhausted upon the tubular part. Before entering the kidney, the *renals* give out,

A. The *Inferior Capsulars.*
B. *Small Phrenics* to the crura of the diaphragm.
C. Many *Adipose* Branches. See below.
D. The *Superior Ureteric.* See below.
E. *Spermatic* Arteries, inosculating sometimes with the *spermatic* branches.
F. Smaller branches, distributed to the mesocolon of each side.

VII. The SPERMATIC ARTERY—Right and Left.—This artery is very slender, but, considering the smallness of its diameter, is the longest that rises from the lateral part of the aorta. It generally has its origin between the *renal* and *mesenteric* arteries, though the right and left do not always issue from the same place; the left often rising

higher, and proceeding frequently from the *renal* or the *inferior capsular*. I have observed, at times, two on each side. It descends from the aorta somewhat tortuously, at a very acute angle, behind the peritoneum, and passes before the vena cava on the right side. It is more tortuous in women than in men, in whom it passes through the abdominal ring. It joins its concomitant vein upon the surface of the psoas muscle. Received by the spermatic cord, it is divided, at some inches before reaching the testes, into five branches: two of which go to the head and opposite extremity of the epididymis; while the rest, running down to the testicle itself, penetrate the tunica albuginea, and send off new branches in every direction; which, proceeding in a winding course, and reflected to the inferior margin of the testes, are partly exhausted on its substance, and partly on the convolutions of the seminiferous ducts. Without any perceptible diminution of diameter, the artery sends out in this course,

A. Middle and Inferior *Adipose* Branches—traversing the middle region of the kidney. See below.

B. *Superior Ureterics.* See below.

C. Branches to the duodenum, the vena cava, and liver on the right; and to the mesocolon on the left.

D. Branches to the lumbar glands, peritoneum, and the spermatic veins.

E. Branches terminating in the spermatic cord, and chiefly in the cremaster muscle and the septum of the scrotum.

In females the artery does not pass through the ring, but, entering the broad ligament, divides into,

a. Posterior Branches---going to the convex side of the ovarium, and entering the ovula by minute twigs.

b. Anterior and External Branches---winding through the alæ to the Falopian tube, and from the tube to the posterior surface of the uterus. They also run down, and inosculate with other *uterine* arteries, and with the branches of the opposite side, Some of them even descend from the abdomen with the round ligament through the ring, and inosculate upon it with the small artery of the *epigastric*, and with the *external pudic* branches.

VIII. ADIPOSE ARTERIES—Right and Left.—These vessels, distributed to the adipose substance round the kidneys, are, on account of their number and origin, divided, like the *capsular*, into certain classes.

A. *Superior Adipose* Branches—rising from all the *capsulars*, viz. the *phrenic*, *aortic*, *renal*, and *first lumbar*, running extensively upon the superior, posterior, and exterior adipose substance of the kidney.

B. *Middle Adipose* Branches—sent out, below the *renal* artery, from the *renal spermatic* and the aorta, to the middle adipose substance of the kidney.

C. The *Inferior Adipose* Branch—rising from the *spermatic*, below the lower extremity of the kidney; and, bending to its posterior and inferior adipose substance, inosculates with the *superior adipose* branches, the *ileo-colics*, and twigs from the *spermatic*.

IX. The URETERIC ARTERIES—which may be reckoned among the smallest branches of the aorta, approach the ureter in different places; and may likewise be divided into,

A. *Superior Uretterics*—rising from the *renal* artery, the *inferior capsulars*, and *spermatics*, run to the pelvis of the kidney, and the upper part of the ureter.

B. *Middle Uretterics*—issuing from the aorta, a little above its bifurcation, or from the *common iliac* or

spermatic, run, with minute twigs, extensively, upwards and downwards, upon the middle part of the ureter, proceeding to the peritoneum of the pelvis and the lumbar glands.

C. The *Inferior Ureteric*—rising from the *inferior vesicals* or *uterine*, near the insertion of the ureter into the bladder, inosculates, upon the bladder, with the former branches, sending off, in every direction, minute ramuli through the whole of the canal.

X. The LUMBAR ARTERIES—Right and Left.—Five in number; issuing from the lateral and posterior part of the aorta, at nearly a right angle. The *first* runs transversely under the first vertebra of the loins. The *fifth*, between the last vertebra and os sacrum, and the rest between the vertebral interstices; while all of them, after being reflected round the spine, sink into the intervening spaces of the vertebræ. The *right* are longer than the *left*. The superior proceed in a straight line, while the inferior incline a little downwards. Two sometimes arise from a single trunk; and all, except the first, are covered by the psoas muscle. They agree in this, that each sends to the adjoining intervertebral space.

A. Two *Spinal* Branches—rising sometimes separately, but most commonly by one trunk, and running in the course of the nerve, as it comes out from the spinal marrow. The *first* is larger, entering the involucrum that lines the vertebræ, forming a plexus with the neighbouring arteries, and constituting arches that encircle the membrane. The *second*, after sending a branch to this membrane and the bone, sinks into the medulla.

B. Muscular Branches—which are again divided into

a. Anterior Branches---distributed to the psoas, lumbar quadratus, and abdominal muscles; and interwoven, anteriorly with the *intercostals*, the *epigastrics*, and the adjoining arteries of the same class.

b. Posterior Branches---ramified on the posterior lumbar muscles; inosculating upon these and the surface of the bones; and running, with various twigs, to the skin.

The FIRST LUMBAR passes behind the crura of the diaphragm, and, penetrating the psoas, bends anteriorly between the transverse muscle and the internal oblique. Besides the *spinals*, already mentioned, it gives

A. A *Phrenic* Branch—inosculating with the former *phrenics* and *adipose* branches.

B. Branches to the quadratus, psoas, and dorsal muscles.

C. Branches to the abdominal muscles, where they reach the *inferior intercostals* and the following *lumbars*.

The FOURTH LUMBAR sometimes goes from a common trunk with its fellow. Of its anterior branches, one winds around the crest of the ileum, and is exhausted upon the transverse and the internal iliac muscles, where also it inosculates with the branches of the *ileo-lumbar*.

The FIFTH LUMBAR, shorter than the others, arises from the *common iliac*, or sometimes from the *ileo-lumbar*; gives *posterior branches* similar to those of the preceding arteries; but its *anterior* branches go only to the internal iliac muscle, and inosculate with the *sacro-lateral* artery.

THIRD SUBDIVISION.

BRANCHES FROM THE TERMINATION OF THE AORTA.

DISTRIBUTION OF THE COMMON ILIAC.

THE COMMON ILIACS exhaust the whole of the aorta. The *Right* Iliac crosses the lower part of the vena cava, near the origin of the iliac vein. The *Left* leans on the outside of its concomitant vein, but does not cover it. A little below, each divides into two branches: the one, named the *Internal Iliac* or *Hypogastric*, sinks into the cavity of the pelvis; the other, called the *External Iliac*, passes to the thigh, where it receives the name of *Femoral*. The *sacro-median*, and, at times, some minute *ureterics*, are, in general, the only branches of the *common iliacs*.

The SACRO-MEDIAN—similar in size to the *lumbar*, is an azygous artery; and, rising from the bifurcation, or a little higher from the middle of the aorta, or from one of the *lumbars*, or sometimes from one of the common *iliacs*, runs down along the middle of the anterior surface of the sacrum, as far as the coccyx, where it forms, with the *sacro-laterals*, an arch whose convexity is downward. In its descent it gives

a. Three or four transverse Branches communicating with the *sacro-laterals*. The first generally inosculating with the last *lumbar* and *ileo-lumbar*.

b. A branch, rising to the rectum, so large as at times to supply the place of the *hæmorrhoidal*, and reach the bladder.

c. Branches sent, in a radiated form, from the *small arch*, to the neighbouring muscles and membranes.

(I.) The INTERNAL ILIAC, or HYPOGASTRIC. Five times larger in the fœtus than the *external*; but, after a year, only equal in size; for while the *umbilical* exhausts almost the whole blood of the trunk, it seems continued into this artery, forming an arch convex downward, from whose circumference the other small arteries of the pelvis are sent off. When passing the brim of the pelvis, behind the peritoneum, it lies, with a more obtuse angle, in the middle, between the ileum and sacrum; thence bending gradually downwards, bstween the pelvis and its viscera. When the *umbilical* artery decays, the trunk distributes its numerous branches in directions so various, that none of them seem to follow its course. As the *common pudic* and *ischiadic*, however, run most directly downward, they have generally been considered by anatomists as its continuation. Its branches, though constant in their destination, are irregular in their origin. Some being distributed to the pelvic viscera, while others run to the external and adjoining parts.

A. The ILEO-LUMBAR, or SMALL ILIAC—rising from the posterior part of the trunk, before or after the *sacro-laterals*, bends upward, and lying

near the crest of the ileum, between the psoas and internal iliac muscles, sends

a. Branches to the Psoas.

b. An *Ascending* Branch—between the last lumbar vertebra and the ileum; where it gives

1. A branch to the iliac muscle, the ileum and sacrum, and the transverse muscle.
2. A branch, passing between the vertebræ to the spinal marrow; inosculating with the adjoining *lumbar* and *sacro-lateral*.

c. A *Transverse* Branch—running, under the psoas, to the hollow of the ileum; divided into

1. A *Superficial* Branch, passing, along the surface of the iliac muscle, to the crest of the ileum; and giving branches to the adipose substance, and the iliac and transverse muscles, where the trunk terminates; and other branches anastomosing with the *femoro-abdominal*.
2. A Deep Branch, traversing the surface of the bone under the iliac muscle, and supplying its nutritious arteries.

B. The SACRO-LATERAL ARTERIES—irregular in origin and number. Sometimes only one, sometimes more, even to five, come off from the trunk, from the *posterior iliac*, or the *ileo-lumbar*. If only one be present, it goes down, near the foramina of the sacrum, as far as the coccyx, and there forms the arch already mentioned. If more, the superior inosculate among themselves; while the inferior terminates in the *sacro-median*. They always give

a. Anterior Branches inosculating with the *sacro-median*.

b. *Spinal* Branches—four or five in number, each of them entering the sacral holes, and distributed to the spinal cavity.

1. An Anterior Branch---forming a plexus internally upon the membranes of the cauda equina, and inosculating with the superior spinal arteries.

2. A Posterior Branch--passing through the posterior hole of the sacrum to the neighbouring parts.

C. The UMBILICAL ARTERY—which, in the fœtus, was the real trunk of the *hypogastric*, reflected upward to the umbilicus, becomes, in the adult, converted almost wholly into a soft spongy ligament, lying in the folds of the peritoneum. A certain portion of it, however, continues open. Having issued from the anterior part of the *internal iliac*, it runs down, transversely and inward, to the lower part of the bladder; but gradually closes as it is reflected toward its posterior side. The ligamentous part which remains, rises still higher upon the sides of the bladder; inclines gradually to its fellow of the opposite side, and at last is inserted, along with the urachus, in the umbilicus. The open portion of the artery sends out,

a. Two or three *vesicals* to the inferior, middle, and superior part of the bladder, inosculating with the other *vesical* arteries.

b. Branches to the ureters and vas deferens, anastomosing with the *pudics*.

c. *Hæmorrhoidal* Branches to the sides of the rectum.

In the female,

a. Branches to the sides of the bladder, uterus, and vagina.

b. A few small branches to the rectum.

D. The INFERIOR VESICAL ARTERIES—varying in size and number, according to the magnitude of the other arteries of the bladder. One,* at least,

is always present, rising near the *umbilical;* which, after running forward to the lower part of the bladder towards the urethra, sends smaller twigs to the rectum, or to the vagina of the female. This artery is larger in men where the *uterine* is wanting; or if two be present, one or both arise from the *middle hæmorrhoidal.* Haller has observed, that they sometimes give origin to the *pudic, ischiadic,* and *obturator.*

a. A branch to the vesiculæ seminales, vas deferens, and prostate gland—running up between the bladder and rectum, and inosculating with the *profunda penis,* or *deep perineal,* and the branch from the opposite side.

b. A branch—going to the bulb, and anastomosing with branches of the *common pudic.*

E. The MIDDLE HÆMORRHOIDAL ARTERY—irregular in its origin, and sometimes wanting; though, in general, it rises between the *pudic* and *posterior iliac,* or from the *pudic* itself. After various flexions near the bladder and the vagina, it runs on the rectum as far as its sphincter. Sometimes it is so large as to give off both the *uterines* and *sacro-laterals.*—In men it gives,

a. Numerous branches, winding on the rectum through its whole descent, and inosculating often with the *mesenteric hæmorrhoidal* and the branches of the opposite side.

b. Branches, running down to the external sphincter, the levator, and the skin, and anastomosing freely with the *external hæmorrhoidals.*

c. Branches, distributed upon the bladder, urethra, seminal vesicles, and prostate gland, as the artery runs

between the bladder and the rectum. If the *middle hæmorrhoidal* only send branches to the rectum, these sometimes form a single trunk.

In women it gives,

a. Intestinal branches.

b. Branches to the vagina, where it lies upon the rectum. These often form a particular *vaginal* trunk.

F. The UTERINE—a large artery, peculiar to the female. It arises near the *hæmorrhoidal, pudic,* or *umbilical.* Between the cervix uteri and the bladder it touches these viscera; traverses the sides of the uterus, and, finally, winds upon its posterior surface. It gives

a. A *Vesical* Branch to the lower part of the bladder.

b. A Descending Branch to the vagina, sending forward small *vesicals*, and inosculating with other vaginal twigs.

c. An Ascending Branch—giving of many tortuous branches to the outer coat of the Fallopian tube, ovarium, and uterus. These inosculate freely with the *spermatics*, and often with the artery of the opposite side.

N. B. An artery frequently rises from the *hypogastric*, or more frequently from the *middle hæmorrhoidal;* which is extensively distributed upon the vagina. In that case, the *descending* branch of the former artery is wanting; and some twigs of this one, ascending to the cervix, inosculate with the *uterine*. In other cases, the vaginal branches are much smaller than those which go to the uterus.

G. The OBTURATOR ARTERY—rising sometimes from the *epigastric* branch of the *external iliac*, and running toward the pelvis; more frequently, issuing from the trunk of the *hypogastric*, the *posterior iliac*, the *ischiadic* or *ileo-lumbar*. It

runs downward and forward, connected to the bones of the pelvis by cellular membrane, following the superior edge of the obturator internus; and, passing through the sinuous depression of the thyroid hole, runs to the thigh with its concomitant nerve and vein. In the pelvis, it gives

a. Branches to the glands situated among the iliac vessels; but which are often wanting.

b. Branches to the levator ani, iliacus internus, psoas, and bone—also often wanting.

c. Branches to the inferior part of the bladder, rectum, seminal vesicles, and prostate gland, inosculating with the *pudic*. These also are often wanting, though at times they are of considerable size, and divide into many smaller branches, running as far as the corpora cavernosa penis.

d. A *Coronary* Branch— running along the superior and internal margin of the os pubis; proceeding under the periosteum, and inosculating with its fellow of the opposite side.

e. Branches to the obturator internus in its passage through the thyroid hole.

Beyond the pelvis it divides into

f. The *External* Branch—running down betwixt the two obturator muscles, following the external margin of the foramen, and bending to the tuberosity of the ischium: afterwards, descending to the back part of the thigh, between the acetabulum and tuberosity, under the quadratus. Gives out

1. Branches to both the obturator muscles.
2. External Branches to the capsule of the joint.
3. A Deep Branch---sinking into the acetabulum, and distributed to the inter-articular fat, the round ligament of the joint, and periosteum.
4. A branch, which after inosculating with the internal branch, is spent upon the large adductor.
5. A branch, inosculating, and forming a *coronary plex-*

us, near the tuberosity of the ischium, with the *internal* branch.

6. A branch, distributed to the posterior part of the capsule, the periosteum of the tuberosity, the adductor magnus, and the quadratus.
7. Many *anastomotic* branches, inosculating with the *descending* branch of the *internal circumflex* on the quadratus; with the *ischiadic* near the quadratus; and with the *external hæmorhoidals* of the *pudic* at the tuberosity of the ischium.
8. Branches---sometimes wanting---distributed, after perforating the quadratus, to the higher extremity of the semitendinosus, biceps, semimembranosus, and surface of the tuberosity of the ischium.

g. The *Internal* Branch—running backward, under the obturator externus to the inner margin of the foramen, and inosculating, by its extreme branches beyond that muscle, with the branches of the *internal circumflex*. From this go

1. Branches to the obturator muscles.
2. A Branch, extending beyond the obturator, above the adductor brevis, to the gracilis and symphysis pubis, and disappearing upon the skin of the genitals. This branch inosculates with those of the *pudic*.
3. Branches, distributed to the capsule, long adductor and quadratus, after the artery has passed the obturator, and inosculating, on the triceps, with the *internal circumflex*.
4. A branch, forming a coronary arch with the *external* branch at the tuberosity of the ischium. From this are sent twigs to the adductor magnus and biceps, anastomosing with the *common pudic*. The remaining trunk, which here runs into the *circumflex*, is sent to the quadratus and the heads of the adductor. But this artery is throughout very irregular.

H. The POSTERIOR ILIAC, OF GLUTEAL — the largest of all the arteries, issuing from the *hypogastric*. It rises from the back part of the trunk, soon after the *sacro-laterals* and *obturator*; passes deeply, upward and backward, to the superior edge of the pyriform muscle, till, concealed by the two origins of the ischiadic nerve, it leaves

the pelvis: then winding externally around the pyriformis, it distributes its branches among the gluteal muscles. Within the pelvis, it sometimes gives rise to the *ileo-lumbar, obturator, sacro-lateralis, ischiadic,* and *common pudic.* Before leaving the pelvis, it gives

a. Branches to the rectum; often wanting.

b. Branch to the ileum and internal iliac muscle.

c. A branch, ramified on the pyriformis, middle and lesser gluteus, and inosculating with the *ischiadic.*

On leaving the pelvis, or soon after, the trunk is divided into

a. The *Superficial* branch—running down betwixt the pyriformis and middle gluteus, under the great gluteus, and again divided into

1. An *Ascending* Branch, bending round the margin of the middle gluteus, and distributing its ramuli to the middle gluteus, the superior part of the great gluteus, the os sacrum, and adjoining part of the ileum. It inosculates at the sacrum with the *posterior sacrals,* and on the surface of the ileum with the *deep branch.* Some branches perforate the gluteus, and become cutaneous.

2. A *Descending* Branch, which soon ramifies, running between the middle and great gluteus; then to the great gluteus, which, having perforated, it terminates in the skin. It gives a branch to the pyriformis, and one which perforating the *ligaments of the ileum,* is distributed to the sacrum.

b. The *Deep* Branch lying under the middle gluteus, where it divides into two, of which the

1. *Superior* Branch--surrounding the origin of the lesser gluteous as far as the spine of the ileum, forms an arch, and runs forward, between the anterior muscles of the thigh, to the skin. It gives

Branches, proceeding from the convexity of the arch, to the middle gluteous and crest of the ileum.

Branches from the concave part of this arch, running between the lesser gluteus and the ilium to the

capsule, and communicating with the *profundissima.*

Branch to the ileum.

2. A *Transverse* Branch--running on the surface of the lesser gluteus, and terminating in its muscular fibres. It gives besides

Numerous branches to the middle gluteus.

The *Profundissima*, or Deepest Artery of the Ileum, running on the surface of the bone, beyond the fleshy part of the lesser gluteus, toward the trochanter and anterior parts of the ileum. It sends off, around the trochanter, some branches to the periosteum, and others to the crest of the ileum, the margin of the acetabulum, and the lesser gluteus; inosculating with the *abdominal*, with the superior ramulus of the *deep branch*, and at the upper extremity of the sartorius with branches of the *external circumflex.*

I. The ISCHIADIC—smaller than the former artery, but observing the same course with the *hypogastric.* It passes from the pelvis, between the lower edge of the pyriformis and the levator ani, and descends, under the great gluteus, parallel with the larger ischiadic ligament. I have observed the trunk divided into two, sending off the *middle hæmorrhoidal* and *pudic.*—Within the pelvis, it gives

a. Many, but irregular, branches to the rectum, uterus, bladder, and obturator internus.

b. Branches to the pyramidalis, inosculating, at the passage of the trunk, outwards with the *pudic* branches.

Without the pelvis,

c. The *Coccygeal*—concealed by that portion of the great gluteus which is attached to the sacrum, coccyx, and the large sacro-sciatic ligament, itself running under this ligament to the coccyx. It is singularly ramified, and gives origin to

1. Branches, perforating the fibres of the ligament and

great gluteus, running to the coccygeus and fat around the levator.

2. A Deep Branch, distributed to the coccygeus, the bone, and the levator ani, inosculating with the *pudic*.

3. Many *Anastomotic* Branches, forming inosculations with the *sacro-laterals* on the outer side of the sacral holes; or, passing through the holes, to the cavity of the pelvis.

d. The *Concomitant Ischiadic*—first approaching the great gluteus, and then running on the surface of the nerve, till it meets with similar arteries, arising below the quadratus from the *internal circumflex* or the *first perforant*.

e. Branches, anastomosing, beyond the tuberosity of the ischium, with the *common pudic* and *internal circumflex*.

f. A branch, which is often divided a second time, bending, downward and forward, between the gemelli and pyriformis, to the trochanter, giving twigs to the lesser and middle gluteus, obturator, gemelli, pyriformis, the nerve, the quadratus, trochanter, articular capsule, and the periosteum of the acetabulum. Of these, some generally inosculate, beyond the pyriformis, with the deep branch of the *posterior iliac*. and still deeper, under the muscle, with the *posterior trochanteric* of the *internal circumflex*.

g. A Deep Branch—running down, before the obturator, to the tuberosity of the ischium; sending twigs to the tuberosity and its muscles, and inosculating with the *pudic* and *obturator*.

h. *Gluteal* branches—numerous—terminating in the great gluteus and the adjoining adipose substance. These exhaust the rest of the trunk.

K. The COMMON PUDIC—the PUDIC—CIRCUMFLEX, INTERNAL, MIDDLE, OF EXTERNAL PUDIC—rising, often from a common trunk, with the *ischiadic*, but easily distinguished by its

smaller size, by its bending more forward and inward while in the pelvis, by its passing out between the pyriformis and the posterior part of the levator ani, and by its greater dtstance from that extremity of the pyriformis which is attached to the sacrum.

Having passed from the cavity of the pelvis, it is concealed by the great sacro-sciatic ligament, under which it runs to the spine of the ischium, and enters the space between the lesser and greater sacro-sciatic ligaments. Having passed the spine, it next runs to the internal surface of tuberosity of the ischium, where, being attached to the bone by the aponeurosis of the obturator internus, it follows the curved margin of the ischium, and bends forward to its ramus. The artery is here exhausted by two branches sent off near the transverse muscle of the perineum. Its branches form three classes.

The *first*, comprehending those arteries which rise from the trunk, within the pelvis, viz.

a. Small branches to the rectum and its conglobate glands.

b. *Vesical* branches—to the lower part of the bladder; and if the branch be large, to the prostate gland, the seminal vesicles, or the vagina. These, as well as the former, are often wanting.

c. A branch to the obturator internus.

The *second* class, the branches issuing from the trunk while situated between the two ligaments, and afterwards traversing the curved margin of the tuberosity of the ischium. These are,

a. Branches, passing before the ligament to the pyriformis and great gluteus.

b. A branch, descending beyond the gemelli and obturator, and inosculating with the *internal circumflex* and *obturator*. It is often wanting.

c. A branch—running transversely, along the margin of the superior gemellus, to the trochanter and its periosteum; sending off two ramuli, to be distributed under the obturator internus on the ischiadic portion of the acetabulum; others inosculating with the *obturator* and *circumflex;* and still others, sinking into the gemelli, obturator, and trochanter. This branch sometimes rises from the *ischiadic*, as was mentioned above at *f.*

d. Branches going outwards, under the ligaments, to the obturator, the periosteum of the tuberosity, and beyond that to the origin of the semitendinosus and triceps magnus. These also generally inosculate freely, around the tuberosity, with the *internal circumflex* and the *obturator.*

e. Branches, issuing from the inner side of the artery; running deep to the coccyx, and inosculating with the *ischiadic coccygeal.*

f. *External Hæmorrhoidal* Branches—a number of them spreading inwards on the levator ani, the surrounding fat, and the sphincter. Some twigs, having perforated the levator, reach the rectum, and inosculate with the *middle hæmorrhoidal.*

g. A branch, rising from the inner margin of the trunk, and divided, near the transverse muscle, to the sphincter, perineum, and transversus perinei.

The *third* class comprehends those branches from the trunk as it bends forward, without the pelvis, toward the ramus of the ischium. Near the transversus perinei, the artery divides, and sends out

a. The *Superficial Perineal*—running, in men, beyond the transversus perinei, in the triangular space between the accelerator urinæ, and erector penis, to be distri-

buted cutaneously—in females, proceeding between the ischio-cavernosus and the constrictor cunni or vaginal sphincter. From this arise,

1. The *Transverse Perineal*, running transversely to the transverse muscle, anal sphincter, and skin: advancing in females to the vaginal sphincter and labia.
2. Branches to the accelerator urinæ.
3. Branches to the erector of the penis, or of the clitoris.
4. Long *Scrotal* Branches in men, and labial in women.
5. Branches to the corpora cavernosa of the penis or clitoris.
6. Branches, inosculating with the *external pudics*, and rising from the trunk, where it approaches the labia or penis.

b. The *Deep Perineal*, or Deep Artery of the Penis or Clitoris—in males, after lying under the transversus perinei, between the accelerator urinæ, and the erector penis, it passes upward, attached by cellular membrane, to the bone, between the ramus of the ischium and pubis and the corpus cavernosum; at last reaching the penis, at the junction of its cavernous bodies, it is there divided.—In females, it runs between the vaginal sphincter, the erector of the clitoris, and its cavernous substance; passing afterwards between this and the os ischium and pubis to the body of the clitoris.

In this course are sent off in males,

1. Two large branches, running into the urethra and its cavernous substance, and afterward to the penis.
2. Smaller branches, rising from each side of the trunk; going to the erector penis, obturator internus, accelerated urinæ, the crura of the corpora cavernosa, Cowper's glands, and the prostate. Those which run to the prostate inosculate with the *inferior vesicles*.

From the above division of the artery proceed

3. The *Dorsal* of the Penis, running upon the back of the penis and surrounding it behind the glans; giving off

   Many branches, inosculating with the former *scrotal* branches; branches to the surface of the corpora cavernosa and the præpuce; branches, inosculating,

near the glans, with similar branches of the opposite side; branches to the præputial frenulum; branches sinking into the glans.

4. The *Profunda*, or *Deep* Branch of the Penis; after anastomosing with its fellow, passes through the corpus cavernosum of its own side, to its other extremity. Many of its branches open into the cavernous cells of the penis; some into the cavernous substance of the urethra; and others, after perforating the septum of the penis, into the cells of the opposite side. Thus are the cellular parts of the penis distended with blood during erection.

From the *Deep Perineal*, or Deep Artery of the Clitoris, in females, arise,

1. Branches from different parts of the trunk, running to the transverus perinei, the fat, erector of the clitoris, clitoris, urethra, and the vagina beneath its sphincter.

The trunk divides into

2. A Large Vaginal Branch.
3. The *Superficial Dorsal* of the Clitoris.
4. The *Profunda*, or *Deep* Branch of the Clitoris; running to the corpora cavernosa, as in males.

(II.) The EXTERNAL ILIAC—the other branch of the *Common Iliac* after it has divided into two branches, near, or a little below, the junction of the sacrum and ileum. It observes the same oblique direction outwards as the *common iliac*. Having passed obliquely over the inner edge of the psoas, and, running behind the peritoneum, upon this muscle and the tendinous portion of the iliacus, it passes to the thigh under the Fallopian ligament, along with the iliac vein, covering it before, and the crural nerve attached to its external side. Having passed Poupart's ligament, it becomes the COMMON FEMORAL. The branches of this artery are,

A. MANY MINUTE BRANCHES—to the psoas, iliacus, lymphatic glands, vessels, peritoneum, and the fat. These are sometimes wanting.

B. The EPIGASTRIC—rising, at an acute angle, from the inner side of the trunk, near the external lateral margin of the abdominal ring and the inferior part of the Fallopian ligament. It first descends; then, being immediately reflected, proceeds inward, behind the internal and posterior surface of the spermatic cord and epigastric vein. Now rising a little higher, and resting upon the peritoneum as it lines the abdominal muscles, it passes the outer and upper commissure of the abdominal ring, and then proceeds inward, under the inferior part of the transverse muscle, bending to the rectus, behind which it ascends to the *umbilicus*. It at last divides into two principal branches; and in this course sends off

a. The *Furnicular* Artery—rising under the furniculus or cord; passing through the abdominal ring, and dividing upon the cellular substance of the cord; where it sends off

1. A Transverse Branch, distributed to the pubis.
2. Branches to the inguinal fat, and the aponeurosis of the external oblique.
3. Smaller Branches, distributed to the cremaster and tunica vaginalis.
4. Branches sinking to the epididymis of the testes.
5. Branches, inosculating with the *spermatic* arteries.

N. B. In females, a branch is reflected from this artery to the uterus, accompanying the round ligament. Others are sent through the ring, to the mons veneris and the labia.

b. Smaller Branches—to the transverse muscle, the posterior sheath, and inferior muscular part of the rectum.

c. Similar Branches—to the peritoneum and transversalis; and through that to the obliquus and the skin.

e. The *External* Branch—the lesser division of the trunk, below the umbilicus; proceeding outward behind the external margin of the rectus, toward the ribs, between the obliquus internus and transversalis; inosculating, in this course, with the external trunk of the *internal mammary*, the *musculo-phrenic*, and the *lowest intercostals*.

f. The *Internal* Branch—larger—running obliquely, under the rectus, to the umbilicus; and dividing into,

1. A *Subcutaneous* Branch, running superficially on the internal margin of the rectus, as high as the ensiform cartilage.
2. A Deep Branch, from which arise Double Branches, perforating the umbilicus to the cavity of the abdomen, along with the umbilical vein and arteries, and others, under the rectus, anastomosing above the umbilicus, with the *internal epigastric* branch of the *mammary*.

C. The CIRCUMFLEX ILIAC, ABDOMINAL, or SMALL EXTERNAL ILIAC—generally smaller than the last, and sent off a little lower from the external side of the trunk; passes, upward and outward, in a retrograde course, under the peritoneum; reaches the crest of the ileum; and bending, parallel to the arched circumference of this bone, proceeds between the extremity of the iliacus internus and transversalis, as also betwixt the transversalis and obliquus internus, where it is finally expended among the abdominal muscles. From this arise,

a. A branch, to the iliacus internus, sartorius, fat, and inguinal glands.

b. A branch to the spermatic cord; often wanting

c. Branches, running to the psoas, crural nerve, and ilia-

cus internus; inosculating frequently with the transverse branch of the *ileo-lumbar*.

d. Four or more branches, of which the exterior are the largest, running to the abdominal muscles, and inosculating with branches of the *intercostal*, *lumbar*, and *mammary* arteries.

e. A branch, on the middle of the crest, anastomosing with the *ileo-lumbar*.

f. Branch, exhausting the artery between the obliquus and transversalis.

DISTRIBUTION OF THE COMMON FEMORAL.

THE COMMON FEMORAL, a continuation of the *External Iliac*, runs without the Fallopian ligament in the groin. The femoral vein, under which it lies, conceals its internal margin, while the whole is covered by a large quantity of cellular substance, fat, inguinal glands, and the fascia of the thigh. Advancing about *two inches*, it divides, on the inferior part of the iliacus internus, into two arteries of nearly equal size. Of these, the continuation of the trunk, is called the *Seperficial Femoral*; and that which rises from the back part of the trunk, the *Deep Femoral* or *Femoral Profunda*. From the common trunk generally arise

A. SMALL BRANCHES—to the skin of the abdomen.

B. INGUINAL BRANCHES—chiefly distributed to the inguinal glands.

C. A SMALLER BRANCH—dividing into ramuli, running outward and transversely, to the upper

part of the sartorius, the iliacus internus, the crest of the ileum, the fascia, and the middle gluteus.

D. MINUTE BRANCHES—to the iliacus, psoas, and pectineus; inosculating with the *internal circumflex.*

E. The SUPERIOR EXTERNAL PUDIC.

F. The MIDDLE EXTERNAL PUDIC.

G. The INFERIOR EXTERNAL PUDIC—These three arteries are distributed to the upper, middle and lower part of the skin and fat of the pudenda, both in males and females. The inferior inosculates freely with the *superficial perineal,* the *obturator* and *internal circumflex.*

H. A BRANCH to the sartorius and rectus, often accompanying the crural nerve deep among the muscles.

N. B. All these arteries vary much in origin, number and distribution.

(I.) THE DEEP FEMORAL—concealed, at its origin, by the *superficial femoral,* the glands, and a quantity of fat, lies in the deep triangular cavity, between the iliacus, pectineus, and adductors; and, bending convexly outward, over the united iliacus and psoas, runs, backward and downward, to the higher extremity of the vastus internus. Having reached the bottom of this cavity, it again bends gently forward; and, passing between the long and short adductors and the vastus internus, runs, downward and backward, near to the middle of the

femur. At last, entering the space between the long and short adductors, or perforating this last muscle, it reaches the adductor magnus, and passes through it, with various branches, running among the posterior muscles of the thigh. The first direction and size of the trunk vary considerably, according as it issues, sooner or later, from the *common femoral*, and according to the number and size of the branches which it sends off. Of these, some are of little consequence; but there are four which merit attention.

A. MANY SMALL BRANCHES—to the iliacus internus, capsule, skin, sartorius, vastus externus and internus, and the heads of the triceps.

B. The EXTERNAL CIRCUMFLEX—a conspicuous branch, and often the first when it arises from this artery; though it sometimes issues from the *superficial femoral*. It bends outward, between the iliacus internus, the rectus and sartorius, and between the tensor fasciæ and the anterior surface of the middle gluteus; then, passing transversely under the tendinous head of the vastus externus, disappears at last near the root of the large trochanter. In this course, its principal divisions are,

a. A branch to the iliacus internus, but returning to the cavity of the pelvis.

b. Another branch, extending, under the iliacus, to the inside of the thigh; inosculating, near the trochanter minor, with a branch of the *internal circumflex*.

c. The *Large Transverse* Branch—constituting the supe-

rior part of the trunk, where it lies under the vastus; and giving out, near to its origin,

1. Branches to the iliacus, tensor fasciæ, and the upper extremity of the sartorius and rectus.
2. Many branches from the anterior part of the trunk, bending upward and outward, and terminating on the tensor fasciæ, and middle gluteus.
3. A Branch, winding outward between the iliacus and lesser gluteus, and spreading on the external surface of the pelvis.
4. The *Anterior Trochanteric* Branch---of small size, lying between the iliacus internus and the anterior margin of the vastus externus. It runs, under the middle and lesser gluteus, on the anterior part of the throchanter major, and terminating in the trochanteric fossa, it inosculates with the *posterior trochanteric*, after sending branches to the foresaid muscles' the bones, and the capsule.
5. Two or three large Transverse Branches, the last ramifications of the trunk---under the vastus externus winding round the root to the back part of the trochanter, and anastomosing, upon the tendon of the greater gluteus, or beyond it, near the bone, with the *first perforant* and the *posterior trochanteric*. From these proceed, branches to the cruralis and vastus externus; minute branches to the surface of the trochanter and femur; subcutaneous branches, forming a circle at the root of the large trochanter.

d. The *Large Descending* branch—rising from the trunk, where it is continued into the *great transverse* branch, and winding under the rectus to the anterior margin of the vastus. In its course to the patella, it is covered, near the cruralis, by the margin of the vastus externus, to which it sends branches. A little above the knee, it inosculates with the *external articular*. It sends

1. A Large Branch to the back of the rectus, communicating with the *anastomotic* of the *superficial femoral*.
2. Transverse Branches---from three to six, running backward to the posterior parts, and communicating with the perforating arteries.

N. B. Besides the inosculations of this trunk with the

superior externo-articular, it forms another with the *superior interno-articular* and the *anastomotic*, by sending a branch, between the cruralis and rectus, to the inside of the thigh, near the patella. The artery varies much in size.

e. The *Small Descending* Branch—rising sometimes from the *superficial*, sometimes from the *large transverse branch* of the *circumflex*: first sending twigs, under the rectus, to the sartorius and vastus internus; then winding inward through the substance of this muscle, inosculates, under the tendon of the triceps, with the *inferior perforant* of the *superficial femoral*, or, more frequently, with the *large anastomotic*.

C. The INTERNAL CIRCUMFLEX—rises, near the origin of the *external*, from the internal and posterior part of the trunk; passes to the middle of the pectineus through the adipose substance, between this muscle and the tendon of the psoas, and runs deeply backward, above the trochanter minor. Concealed here by muscles and fat, it divides into branches, between the short and great adductor, or between the adductor and pectineus. Of these branches, the largest approaches the neck of the femur, acetabulum, and obturator externus, and, proceeding outwards and backwards to the interstice between the quadratus and adductor magnus, divides into two branches, and is partly expended on the muscles attached to the femur, and partly through the interstice to the flexors of the thigh. Thus are produced, in the following order,

a. Branches to the iliacus internus, psoas, pectineus, and capsule.

b. Transverse branches to the pectineus, long and short adductor, and gracilis, anastomosing, with branches

of the *superficial femoral* and *external circumflex*, and more deeply with twigs of the *obturator*.

c. Many branches, rising separately while the trunk passes between the trochanter minor and the acetabulum; distributed to the heads of the triceps, pectineus, and capsule, and inosculating frequently with other branches of the *profunda*.

d. The *Superior* branch, or *Superior Anterior Ascending*, seemingly one-half of the trunk—runs transversely, between the short and great adductors, toward the symphysis.

1. A branch through the depression in the acetabulum to the glands, cartilages, and round ligament of the joint.
2. A branch, ramified on the obturator externus.
3. Branches, distributed to the capsule, and in many places to the great and short adductors.
4. Branches, derived from these, or rising separately; inosculating, at the external and posterior margin of thyroid hole, with the *external* and *internal* branch of the *obturator*.

The rest of the artery, after distributing, in this course, various branches to the adductors, gracilis, and genital integuments, inosculates with the *external pudics*.

e. The *Inferior* Branch, or *Inferior Posterior Circumflex*—a continuation of the trunk—runs, over the lesser trochanter, to the neck of the femur; distributing small branches to the capsule of the joint, the acetabulum, obturator, and great adductor. Between the quadratus and great adductor it divides into,

1. The *External*, or *Superior External* Branch—often called the *Posterior Trochanteric*.—This smaller ramulus, concealed by the quadratus, runs obliquely, outward and upward, to the posterior part of the bone, and, as it approaches the trochanter, divides into two branches; the larger ascending obliquely upward to the trochanteric fossa, and the smaller descending in a different course. Thus are produced, branches to the great adductor and obturator externus; inosculating frequently with the *external* branch of the *obturator*; branches to the capsule,

bone, and quadratus; a branch, inosculating, near the origin of this smaller trunk, with the *concomitant ischiadic*, which sends a twig between the quadratus and the great adductor; branches, inosculating, at the root of the trochanter major, with the *transverse* branches of the *external circumflex*.

From the *Ascending* Branch of the divided trunk proceed,

A branch, communicating, behind the quadratus and gemelli, with the *deep branch of the ischiadic*, and with a twig of the *common pudic*, that runs down beyond the gemelli. This last one Haller considers as a trunk, and gives it the name of *superficial*; but regards the other as a branch of this *superficial*, and denominates it the *posterior trochanteric*.---Branches, inosculating, in the trochanteric fossa, with the *anterior trochanteric* and the *profundissima* of the *posterior iliac*.

From the *Descending* Branch proceeds,

A considerable ramulus, receiving a twig from the *first perforant*, above the higher part of the adductor, near the root of the trochanter.

2. The *Internal* Branch, or *Inferior Internal*, generally larger than the former, rises, near the tuberosity of the ischium, between the quadratus and adductor; and, passing through the adipose substance, runs to the common origin of the flexors of the thigh. It here spreads into numerous ramifications, distributed, partly to the tuberosity itself, where inosculations are formed by the *ischiadic*, *obturator*, and *pudic*; partly to the flexors, but chiefly to the great adductor.

D. The FIRST PERFORANT — running backwards from the trunk, below the small trochanter; and between the pectineus and short adductor, or between its fibres, proceeds, near the vastus internus, obliquely outward, between the femur and that part of the great adductor which is attached to the bone. About an inch from the great trochanter, it perforates the adductor in two places, under the covering of the great gluteus; to which, and the flexors, it distributes its ultimate branches. From this arise

a. Large branches to the vastus internus, and to the short and great adductors.

b. Branches, spreading out from the concealed trunk to the adductor, quadratus, and trochanter.

c. An *Ascending* Branch—forming, above the upper extremity of the great adductor, an inosculation with the *descending* branch of the *posterior trochanteric.*

d. A *Large Transverse* Branch—sometimes double—running, under the adductor, to the gluteus; and, after perforating the tendon of this muscle, proceeding outwards, round the root of the trochanter, to the vastus externus, where it inosculates with the large *transverse* branch of the *external circumflex.*

e. A Branch—often double—rising, as it were, from the former, passing through the adductor to the great gluteus; and there dividing into various branches, inosculating with the *gluteal* branches of the *ischiadic.*

f. A Nutrient Branch—running down upon the surface of the bone, and anastomosing with a nutrient branch of the *second perforant.*

g. *Descending Perforant*—penetrating the great adductor to the flexor muscles. Here it divides into many branches to each of the flexors and the great adductor, and forms many communications on these muscles with the *internal* branch of the *inferior circumflex,* with some recurrent branches of the *second perforant,* and sometimes, though more rarely, with twigs of the *superior pe forant* rising from the *superficial.*

E. The SECOND PERFORANT—a continuation of the trunk—passes, sometimes single, and at others double, between the long and short adductor, or through the long adductor itself; then proceeding obliquely outward and downward, between the femur and great adductor, and penetrating the adductor near the linea aspera, at the middle of the thigh, and inner side of the short head of

the biceps, is exhaused, like the last artery, among the flexor muscles by a *descending perforant* branch. This artery sends off

a. Large branches—sinking into the vastus internus and long adductor, before the immersion of the trunk.

b. Another branch, partly distributed to the vastus, partly entering the bone by two twigs, and inosculating with the large nutrient artery.

c. A Large Branch—often double—entering, like the trunk, the long adductor, but higher.

d. An Ascending Branch—inosculating, near the trochanter, upon the back part of the bone, with the *first perforant.*

e. A *Superior Transverse* Branch—running a little below the tendon of the great gluteus, between this muscle and the femur, to the substance of the vastus externus, and anastomosing with the *transverse* branches of the *large descending* branch of the *external circumflex.* A branch sometimes rises suddenly from this one, beyond the great adductor, distributed to the external flexors, and known by the name of the *third perforant.*

f. An *Inferior Transverse* Branch—running in the same direction as the last; and, about two or three inches below the tendon of the great gluteus, passes, under the short head of the biceps to the vasturs externus. If the artery proceeds farther, it gives rise, like the the last, to a *fourth perforant.* It gives

1. Many Branches, winding on the adductor.
2. The Large *Nutrient* Branch of the Femur, running down, near the short head of the biceps, on the outer side of the linea aspera; inosculating with a small *inferior nutrient* branch from the *inferior perforant* of the *superficial femoral,* and penetrating the bone with a larger *external* branch. This artery is irregular both in origin and direction.
3. A Branch to the biceps.
4. Branches, meeting the *descending* branch of the *circumflex* on the vastus externus, and sometimes the

superior externo-articular. They appear to rise from the *nutritious* branch in such a manner, that it seems to be inflected through the short head of the biceps to the vastus externus.

g. Many branches to the short head of the biceps.

h. A *Descending Perforant*, passing to the flexors, after perforating the adductor. Like *g* of the *first perforant*, it forms, upon the surface and substance of these muscles, inosculations upwards with this artery, and downwards with the *perforant* of the *superficial*.

(II.) The SUPERFICIAL FEMORAL ARTERY—lying externally, and covered, through its whole course, by the *broad fascia*, by the inguinal glands above, and on the middle part by the sartorious as it runs obliquely across the femur. It then proceeds downward, inward, and backward, passing gradually from the anterior to the inner surface of the thigh, and from that to the ham or poples. At first it is separated from the deep femoral by a quantity of fat and by the glands; then lies upon the vastus internus; and, passing along in a declivity between the vastus internus and adductors, enters the oblique canal in the common tendon of the adductors. Having passed through this canal, it takes the name of *Popliteal* Artery, where it runs from the inner to the back part of the thigh. Before reaching the posterior part, it passes over two-thirds of the femur; and though the thigh be here more slender than at the superior part, it lies more deeply concealed among the muscles.

A. NUMEROUS BRANCHES—irregular in distance, order, and situation—rising from the trunk as it runs along the anterior and inner part of the thigh, and distributed to the inguinal glands and sartorius, and through this to the skin; also to the rectus, vastus internus, long and short adductors, and gracilis. Of these, some are larger, some less—entering the muscles, in different places, from three to six.

B. The LARGE ANASTOMOTIC BRANCH—rising from the inner surface of the trunk, at the superior margin of the tendinous canal; and, bending downwards spreads, with many serpentine ramifications, on the vastus internus, into which it sinks. From this proceed,

a. A Branch to the sartorius and skin.

b. A Branch—running to the outer margin of the tendon of the sartorius before the trunk reaches the vastus internus; and passing with the tendon over the joint of the knee, to the fascia and skin of the leg. It first, however, gives many branches to the knee, inosculating with the *inferior articulars*, and with the recurrent branch of the *anterial tibial.* Like the following artery, it often rises separately from the *femoral* trunk.

c. A Branch—rising in the tendinous canal, and accompanying the tendon of the triceps which covers it, to the inner condyle of the femur, where, running downwards, it spreads into various ramifications. It also sends off a branch under the tendon, as it is attached to the condyle, which runs transversely, upon the periosteum of the condyle, to the common tendon of the extensors and the external condyle, where it forms an arch, around this extremity of the femur, with the *superior* and *inferior externo-articulars*, distributing twigs to the cavity of the joint.

d. A Branch—running transversely, perforating the vastus near the rectus, and there inosculating with a branch of the *external circumflex.*

e. A Branch—rising in a similar manner from the vastus, and inosculating, on the surface of the knee, with the *articular* branches.

f. A Branch—passing upwards, anastomosing, upon the vastus or cruralis, with the *small descending* branch of the *circumflex.*

C. The SUPERIOR PERFORANT—issuing from the outer side of the trunk, where it lies concealed by the tendon of the triceps; and, bending transversely backward, between the posterior surface of the bone and the inferior muscular part of the great adductor, near the origin of the short head of the biceps, penetrates the fibres of this muscle, or those of the adductor, to the flexors of the thigh—Sending off, in this course,

a. Branches to the adjacent muscles.

b. A *Perforating* Branch, inosculating with *descending* branches of the *second,* and with *ascending* branches of the *inferior perforant.*

N. B. The *Perforating* branch of this and the following artery is sometimes wanting; and the trunk is inflected under the biceps only to the vastus externus, inosculating with the neighbouring *articular* artery.

D. The INFERIOR PERFORANT—issuing a little below the last, from the external margin of the trunk; running transversely under the adductor magnus, at the posterior surface of the femur, to the short head of the biceps, and under that to the vastus externus. It sometimes extends to the cruralis, and is often double. It gives

a. Minute branches to the adjacent muscles.

b. The *Inferior Nutrient* Branch—sent upwards from the trunk as it passes under the short head of the biceps; inosculating near the linea aspera, with the *superior nutrient* branch, and terminating in the bone. It is sometimes sent off from the former *perforant.*

c. A *Perforant* Branch—running, in the ham to the semimembranosus, and inosculating with the *superior perforant.* Sometimes wanting.

d. Branches—anastomosing, on the vastus externus, with the *larger* and *lesser descending* branches of the *external circumflex.*

e. A Branch—bending to the vastus internus, and sometimes nosculating, under the tendon of the triceps, with a *lesser descending* branch.

The POPLITEAL ARTERY—that part of the *Superficial Femoral* which runs along the ham. Its superior part is bounded by the posterior margin of the tendon of the triceps, and its inferior by the higher extremity of the soleus muscle, under which it divides into the *Anterior* and *Posterior Tibial* Arteries. Being covered externally by the aponeurosis which surrounds the joint, it runs obliquely, outward and downward, through the adipose substance between the flexor tendons, passing into the cavity between the condyles and the heads of the gastrocnemii. As it proceeds over the joint of the knee, it lies upon the capsule, and afterwards on the popliteal muscle. The numerous branches to which, in this course, it gives origin, are divided into *Articular* and *Muscular.* Of these, the first are,

A. The SUPERIOR EXTERNO-ARTICULAR, from the outer side of the trunk, above the condyle, and running under the tendon of the biceps, to the vastus internus, divides into two ramuli.

a. Small branches to the periosteum, capsule, biceps, and gastrocnemii.

b. *Deep* Branch—penetrating the vastus to the external condyle, and there interwoven with the *inferior externo-articular*, and the perforating branches of the *superficial femoral;* running also transversely to the internal condyle, and inosculating with the *superior interno-articular.*

c. *Superficial* Branch bending towards the upper edge of the patella, and anastomosing with the *large descending branch of the circumflex*, and, under the tendon of the rectus, with a branch of the *large anastomic;* and uniting with the *vascular plexus* of the knee, formed by all the *articulars.*

B. The SUPERIOR INTERNO-ARTICULAR—running, above the inner condyle, from the interior edge of the trunk, under the tendon of the triceps, to the patella. Its branches supply the ligaments of the joint, and anastomose with the other articulars.

C. The MIDDLE ARTICULAR, or AZYGOS—rising sometimes from the superior and outer surface of the *popliteal*, at other times from the *external* or *internal superior articular;* runs always to the posterior part of the capsule, the semilunar cartilages, and the crucial ligaments.

D. The INFERIOR EXTERNO-ARTICULAR—rising below the knee, passes under the plantaris and external head of the gastrocnemius, to the top of

the fibula, and there entering, under the external lateral ligament and aponeuroses, a groove formed in the external semilunar, cartilage, proceeds, between the femur and the head of the fibula, to the patella.

a. Separate branches to the popliteus, soleus, gastrocnemius, skin, and periosteum.

b. Branch, forming a conspicuous inosculation with the *tibial recurrent.*

c. *Superficial* Branch—transmitting small ramuli to the vascular plexus of the knee, and inosculating with the *superior externo-articular.*

d. Small Branches to the semilunar cartilage, periosteum, and capsule.

e. *Deep* Branch—entering the capsule near the patella, and spreading within the cavity of the joint.

E. INFERIOR INTERNO-ARTICULAR—descending between the superior edge of the popliteus and the gastrocnemius, to the posterior angle of the inner condyle of the tibia; then passing, under the internal lateral ligament, and the tendons of the internal flexors, to the lower margin of the patella.

a. Branches to the popliteus, posterior and crucial ligaments, capsule and tendons of the flexors; one inosculating with the *nutrient* branch of the *posterior tibial.*

b. *Superficial* Branches to the inferior edge of the patella, communicating with the *anterior tibial.*

c. Branches to the ligament of the petella, inosculating with the *superior* and *inferior externo-articular.*

d. *Deep* Branch to the cavity of the joint.

N. B. The vascular plexus, covering the knee, is formed by all the *articular* arteries, the *recurrent tibial*, cir-

cumflex, large anastomotic, and twigs of the *perforants.*

F. Of the MUSCULAR BRANCHES, which are infinitely varied, the following chiefly merit attention.

a. Two or three *Conspicuous* Branches, often wanting to the flexors. These sometimes supply, by *reflected* branches, the want of *perforants* from the *superficial femoral.*

b. Two *Gastrocnemial* Branches—running parallel between the heads of the gastrocnemius to the internal side of the muscle. Of these, one runs, on the surface, to the tendo Achillis, as far as the os calcis.

c. Two Branches to the soleus; sometimes wanting.

d. Branches to the plantaris, periosteum, vessels, and nerves.

[I.] THE ANTERIOR TIBIAL ARTERY—smaller than the *Posterior*—rises anteriorly from the *popliteal,* at the inferior margin of the popliteal muscle, and, perforating the interosseous ligament, runs to the anterior part of the leg. It descends on the ligament, at first between the tibialis anticus and common extensor, then between the anticus and the extensor longus of the great toe. In this course, it lies nearer to the fibula than the tibia; but gradually separating from the ligament, it turns forwards and inwards the farther it descends; and passing over the lower extremity of the tibia, and the tarsus along with the extensor tendons, under the crucial ligament, divides between the first and se-

cond metatarsal bones, into two branches: of which one, sinking between the bones to the planta of the foot, inosculates with the branches of the *posterior tibial*, while the other, passing along the dorsum of the foot, runs to the great toe. Its most remarkable branches are,

A. BRANCH to the origin of the tibialis posticus, or

B. ASCENDING BRANCH—transmitting twigs under the popliteus, to the external and posterior part of the tibia and capsule, and thence to the head of the fibula, soleus and joint, inosculating with the *inferior articular*.

N. B. These branches are sent off behind the interosseous ligament.

C. The TIBIAL RECURRENT—winding to the anterior surface of the knee, and giving

a. Branches to the adjacent muscles and ligaments.

b. Branch—winding round the head of the fibula under the common extensor of the toes and the peroneus longus, and inosculating with B.

c. Branches—inosculating with the *inferior articular*.

D. LARGE BRANCH—running down upon the fibula, between the tibialis, peroneous longus, and extensor communis, inosculating, near its inferior extremity, with the *fibular*.

E. MINUTE BRANCHES—to the tibialis anticus, extensors, peronei, aponeurosis, and periosteum of the bone.

F. BRANCHES—to the extensor tendons and surface of the bone, meeting there the *posterior tibial* and *anterior fibular*.

G. The INTERNAL MALLEOLAR—spreading on the

inner ancle, the capsule, astragalus, os naviculare, and cuneiforme; and uniting with branches of the *internal plantar.*

H. The EXTERNAL MALLEOLAR—forming a large communication with the anterior *fibular,* or some of its branches—winding to the external ancle, where it sends branches to the peroneus brevis, the joint, the short common extensor, and the tendons of the peronei; forming, under these, inosculations with the *posterior fibular,* and anteriorly with the *anterior fibular.* It at last reaches the *tarsal arch.*

I. BRANCHES—to the extremity of the tibia, the hollow of the tarsus, capsule, extensor tendons, and the tarsal bones communicating with the *fibular,* and with the *internal plantar.*

K. The TRANSVERSE TARSAL, or TARSAL—sent from the external side of the trunk, to the surface of the second row of tarsal bones, uniting, at the fifth, with the *external plantar;* and thus forming the *tarsal arch.* It gives

a. A Branch to the ancle joint, inosculating with the *posterior fibular* and *external malleolar.*

b. Branch to the hollow of the tarsus.

c. Branches to the extensor brevis.

d. Branches to the cuneiform bones and cuboides.

e. The *First Dorso-metatarsal,* or *Dorso-interosseal.*

f. The *Second Dorso-metatarsal,* or *Dorso-interosseal.*

g. The *Third Dorso-metatarsal,* or *Dorso-interosseal.*—These arteries pass between the metatarsal bones, and terminate in the planta-digital arteries.

h. Branch from the inosculation of the *transverse tarsal* and *external plantar;* running along the fifth metatarsal bone to the adductor of the little toe.

N.B. The *Dorso-metatarsals*, or *Dorso-interossels*, often arise from the *transverse metatarsal;* in which case, the *transverse tarsal* only produces minute branches, inosculating, near their origin, with the *dorso-metatarsals*. Sometimes, also, the *dorso-metatarsals* give origin, by meeting with the *perforants*, to one or two *planta-digital* branches; or produce other *digitals*, spreading on the back of the toes, and inosculating with the true *digitals* of the *external plantar*.

L. BRANCHES—from the inner edge of the artery, to the same side of the tibia, the extensor tendons, the periosteum, and the naviculare and first cuneiform bone.

M. BRANCH—to the abductor pollicis, and inosculating with the *internal plantar*.

N. BRANCH to the abductor pollicis, running along the inner side of the back of the great toe.

O. BRANCH—from the external edge, between the *transverse tarsal* and *transverse metatarsal*, to the extensor tendons and the short common extensor.

P. The TRANSVERSE METATARSAL ARTERY—varying in size, and sometimes entirely wanting, according to the number and magnitude of the branches which are sent off from the *transverse tarsal*. It runs to the commencement of the first and second metatarsal bones, and passing transversely to the little toe, gives rise to *metatarsal* branches, if not already supplied by the *transverse tarsal*. It is exhausted on the abductor of the little toe, peroneal tendons, and plantar integuments.

Q. The DORSO-METATARSAL, or EXTERNAL DORSAL of the GREAT TOE—the superficial branch of the

anteriar tibial. It traverses the outer margin of the first metatarsal bone, and gives,

a. Minute branches to the metatarsal bones and extensor tendons.

b. Dorso-tibial, or *Internal Dorsal* Branch of the Second Toe---running along the *tibial* side of this toe.

c. Dorso-fibular, or *External Dorsal* Branch of the Great Toe—uniting with the external plantar of the great toe, and running to the termination of the toe.

B. The DEEP ANASTOMOTIC BRANCH—entering the sole of the foot, and, sending branches to the abductor and adductor, inosculates with the *plantar arch.* From this inosculation generally arises the *planta-pollicar.*

[II.] THE POSTERIOR TIBIAL——the other branch of the *Popliteal*—passes down, under the soleus, upon the posterior surface of the flexor longus and tibialis posticus, to the lower extremity of the tibia, is afterwards inflected to the sole of the foot, behind the internal ancle. While there covered by the laciniated ligament, and fat, it meets the broad extremity of the abductor pollicis, and divides into two branches: One of which, passing to the great toe, is the *Internal Plantar*; the *External Plantar*, runs to the sole, between the flexor brevis and longus and under these, still deeper, to the fifth metatarsal bone. Here returning to the great toe, by an oblique and transverse flexion under the tendons of the flexor longus, it forms the *plantar arch.* Its branches are,

A. BRANCHES to the inner head of the gastrocnemius; often wanting.

B. The LARGE NUTRITIOUS ARTERY of the TIBIA, or POSTERIOR INTEROSSEAL—spreading downwards, between the flexor of the toes and *posterior tibial*, upon the interosseous ligament, and inosculating with the *fibular* at the inferior extremity of the tibia. From this issue,

a. Branch to the soleus, popliteus, and periosteum of the tibia, communicating with the *inferior interno-articular*.

b. Branch to the tibialis posticus.

c. Branch to the bone.

d. Branches to the periosteum of the tibia, the tibial muscle and the common flexor.

C. A LARGE BRANCH—winding round the head of the fibula, under the muscles, and anastomosing branches of the *tibial recurrent*.

D. MANY LARGE BRANCHES to the soleus, interwoven everywhere with the *fibular*.

E. SOME CUTANEOUS BRANCHES—running with the veins and nerves, and anastomosing with the *anterior tibial*.

F. The COMMON FIBULAR, or PERONEAL—very irregular in size and the distribution of its branches. It often equals in dimension the *anterior tibial*; sometimes is entirely wanting; and at other times is rather smaller than the *posterior tibial*. Rising, near the upper part of the *tibialis posticus*, it descends between this muscle and the flexor pollicis, by which, a little lower, it is covered; and at last it touches the interosseous ligament. Near the inferior part of the bones, it divides into the *anterior* and *posterior fibular*. It gives

a. Branches—passing through the soleus to the skin, inosculating with the *inferior fibular*, and the *posterior tibial.*

b. Branch—penetrating the peroneous longus and the skin.

c. Branches to the tibialis, the common flexor of the great toe, and the periosteum of the fibula.

d. Many branches—winding tortuously under the flexor pollicis and peroneous longus, to the anterior part of the fibula, inosculating there, with twigs from the *anterior tibial.*

e. Many branches—rising, in various places, and distributed to the tibialis posticus, peronei, flexor pollicis, the inferior tendon of the soleus and gastrocnemius, the periosteum, interosseus ligament, and skin.

f. The *Nutrient* Artery of the Fibula, to the periosteum and the substance of the bone.

g. The *Posterior Fibular*—the largest and most constant branch. It running behind the external malleolus, to the outer surface of the os calcis, inosculating with the *external plantar*, or else is expended on this abductor muscle and the skin. It often gives,

1. Branches to the long flexors of the toes and the peronei.
2. Large *Transverse Anastomotic* Branch, uniting on the periosteum of the tibia, with the *posterior* and *anterior tibial.* Other ramuli are sometimes sent to the ancle joint, which communicate with the *fibular* and *external malleolar.*
3. Branch to the external cavity of the calcaneum, anastomosing with the *anterior tibial.*
4. Branch to the external side of the calcaneum, communicating with the *posterior tibial* and *external malleolar.*
5. Branches to the peroneal tendons and sheaths, inosculating with the *anterior fibular.*
6. Branches to the abductor of the little toe, inosculating with the *external plantar.*

h. The *Anterior Fibular*—passes through the interstice of the bones of the leg, in the angle between the extremities

of the tibia and fibula, comes out behind the extensor pollicis and short peroneus, where it inosculates with the *external malleolar;* and then proceeds with the tendon of the peroneus, to the os cuboides, where it inosculates with the *external plantar.*

1. Branch to the fibula, peroneal tendons, and periosteum of the tibia.
2. *Transverse Anastomotic* Branch, behind the extensors, an inosculation with the *anterior tibial.*
3. Branch to the capsule of the joint, inosculating with various *metatarsal* branches.
4. Branches inosculating at the exterior side of the calcaneum, with the *posterior fibular.*
5. Branches, inosculating with the *transverse tarsal,* on the os cuboides, and contributing to the *tarsal arch.*
6. Branches to the abductor of the little toe.

G. Numerous branches in the course of the artery, to the adjoining flexor muscles.

H. Transverse branches anastomosing, as already noticed, with the *posterior fibular.*

I. Branch to the internal malleolus, anastomosing with the *posterior tibial* and *internal malleolar.*

K. Branches to the flexor tendons and their sheaths.

L. Two large branches to the calcaneum, inosculating with the *fibular.*

M. Deep branch to the astragalus and calcaneum.

N. Deep branch to the other adjoining bones and their ligaments.

O. The external plantar—the larger branch of the *posterior tibial*—passing between the short flexor of the toes and the *massa carnea,* to the inner edge of the abductor of the little toe. As it proceeds to the base of the metatarsal bone of this toe, it runs gradually inward to the great toe, and forms the *plantar arch,* which unites with the

anterior tibial, in the first interstice of the metatarsal bones.

a. A *Transverse Anastomotic* Branch—running along the anterior tuberosity of the os calcis, and inosculating with the *anterior tibial,* at the inner side of the tuberosity, and with the *posterior fibular* at the outer side.

b. Branches to the large ligament of the calcaneum.

c. Many branches—through the adjacent muscles to the aponeurosis and skin.

d. The *First Deep* Branch, or *First Profunda* uniting with the *posterior fibular* on the external lateral part of the calcaneum, and with the *deep branch* of the *internal plantar* on the surface of the calcaneum.

e. The *Second Deep* Branch, or *Second Profunda*—distributed in the same manner as the former artery, and contributing to the plexus in the cavity of the foot.

f. Branches to the abductor of the little toe, and periosteum of the adjoining bones.

g. The *Planta-digital,* or *External Plantar* of the Little Toe—issuing from the trunk as it begins the formation of the *arch,* and passes on the outside of the little toe to its apex.

h. The *Second Planta-digital.*

i. The *Third Planta-digital.*

k. The *Fourth Planta-digital.* These arteries arise at the intervals between the metatarsal bones, proceed to the toes, and then covered by the transversalis, divide into two branches, to be distributed to the toes as those of the ulnar artery to the fingers. At the point of bifurcation, they communicate with the *interosseæ dorsalis;* the *third* and *fourth* join all the *plantaris interna.*

Between these DIGITALS, two or three *deep interosseals,* or *planta-metatarsals,* and four *perforants,* issue from the *plantar arch.*

l. A *Planta-metatarsal,* or *Deep interosseal* Branch runs between the sixth and seventh interosseous muscles, and inosculates with neighbouring branches.

m. Another *Deep Planta-metatarsal*—runs out, in the third interstice, between the fifth and sixth interosseous muscles, and is similarly distributed.

n. The *Plantar*, or *Posterior Perforant* of the Fourth Interstice.

o. The *Plantar*, or *Posterior Perforant* of the Third Interstice.

p. The *Plantar*, or *Posterior Perforant* of the Second Interstice.

q. The *Plantar*, or *Posterior Perforant* of the first Interstice.—These pass between the metatarsal bones to the back of the foot, and anastomose with the metatarsia.

r. *Three* branches—from the concave margin of the arch, communicating with the *deep* branches of the *internal* and *external plantars*.

The *External Plantar*, bending to the first metatarsal interstice, inosculates with the *anterior tibial*; and running forwards, under the adductor, to the fibular side of the metatarsal bone of the great toe, gives rise to

s. The *Planta-pollicar*, or *Internal Pollicar*, at times, rather arising from the *anterior tibial*, which then presents another branch, uniting with the *external plantar*. It gives off,

1. Branch, sending out the *digito-tibial* of the second toe, and the *digito fibular* of the great toe; inosculating with the *profunda fibular* of the *internal plantar*.
2. The *Digito-tibial* of the Great Toe, passing as far as the apex. It receives the *profunda median* and *profunda-tibial* of the *internal plantar*.
3. The *Dorsa-tibial* of the Great Toe, generally running to the termination of the second phalanx and nail, and forming an *arch* with the *dorso-fibular*, which rises from the *anterior tibial*.

N. B. All the *Digitals* send many twigs to the skin, bones, and ligaments; and unless separate *dorsal*

branches are formed by the union of the *metatarsals* and *perforants*, they give origin to *dorsal branches*.

P. The INTERNAL PLANTAR—rising in the sinuosity of the calcaneum, between the tendon of the tibialis posticus and the origin of the abductor pollicis, runs along, covered by this muscle, and divides, under it, into four branches, which follow the course of the abductor and flexor brevis of the great toe, to the inferior extremity of the metatarsal bone of this toe, and terminate in branches of the *planta-pollicar* that issues from the *anterior tibial* and *external plantar*. It sends off,

a. A branch to the tendons of the flexors, and the periosteum of the astragalus, inosculating with the *internal malleolar*, and with the branches of the *anteterior-tibial*.

b. Branches to the abductor and flexor brevis communis.

c. A branch to the flexor brevis, the massa carnea, and ligament, inosculating with the *deep external plantar*.

d. The *Profunda-tibial*, or *Internal Deep* branch of the *Internal Plantar*—the first ramulus of the four branches of the *internal plantar*—rising at the ôs naviculare, and following the inner edge of the abductor pollicis, and inosculating with the *digito-tibial* of the *planta-pollicar*. It gives rise to,

1. Many Cutaneous Branches.
2. Branches---sent to the dorsum of the foot, and inosculating with the *anterior tibial*.
3. Branches---to the tarsal bones.

e. The *Profunda Median*, or *Deep Middle* branch of the *Internal Plantar*—It lies under the abductor, and, after running along the middle cuneiform bone and the first metatarsal bone, unites with the *planta-pollicar*, or *digito tibial* branch of the *pollicar*. It sends

also twigs to the fat and skin, and others inosculating with the former.

f. The *Profunda Fibular*, or *Deep External* branch of the *Internal Plantar*—running between the flexor brevis and abductor pollicis, towards the second toe, it at last unites with the *digito-tibial* of the second toe, and the *digito-fibular* of the great toe. It gives,

1. Branches to the flexor of the great toe, the common flexor, and abductor.
2. Cutaneous Branches.
3. A Small Branch, inosculating with the *digital* branches, and forming a *superficial arch* with them.

N. B. From these three branches, the *planta pollicar* receives a considerable increase.

g. The *External* Branch of the *Internal Plantar*—passing between the massa carnea and ligament of the calcaneum, to the os cuboides, and sending twigs to the neighbouring muscles, the tarsal ligaments, and the whole plantar cavity. It anastomoses with the *profundæ*, with the *external* and *internal plantar.* But it should be remembered, that the branches of the *plantar* present as numerous varieties as the other arteries of the foot.

TABLE OF THE ARTERIES.

THE AORTA,	AORTA.

BRANCHES FROM THE ARCH OF THE AORTA.

I. Right Coronary,	Arteria Coronaria Dextra
II. Left Coronary,	Sinistra,
III. Right Subclavian,	Subclavian,
IV. Common Carotid,	Carotis Communis.
Common Carotid,	Carotis Communis.
External carotid,	Arteria carotis externa,
Superior thyroid,	thyroidea superior,
Lingual,	lingualis,
Labial,	labialis,
Ascending pharyngeal,	pharyngea ascendens
Occipital,	occipitalis,
Posterior auricular,	auricularis posterior,
Superficial temporal,	temporalis superficialis,
Internal maxillary,	maxillaris interna.
Internal carotid,	carotis interna,
Posterior of the receptacle,	receptaculi posterior,
Anterior of the receptacle,	receptaculi anterior,
Opthalmic,	opthalmica,
Communicating,	communicans,
Anterior carotid,	carotis anterior,
Posterior carotid,	carotis posterior,
Two nameless branches.	
Subclavian,	Subclavia,
Internal mammary,	Arteria mammaria interna,
Inferior thyroid,	thyroidea inferior,

Superior intercostal,	intercostalis superior,
Vertebral,	vertebralis,
Deep cervical,	cervialis profunda,
Superficial cervical,	cervicalis superficialis.
AXILLARY,	AXILLARIS,
Highest thoracic,	Arteria thoracica suprema,
Long thoracic,	longior,
Humeral thoracic,	humeraria,
Alar thoracic,	alaris,
Inferior scapular,	scapularis inferior,
Posterior circumflex,	circumflexa posterior,
Anterior circumflex,	anterior.
HUMERAL, or BRACHIAL,	HUMERARIA, S. BRACHIALIS,
Large profunda,	Arteria profunda humeri,
Large nutritious of the humerus,	nutritia magna humeri,
Lesser profunda,	profunda minor,
Large anastomotic,	Ramus anastomoticus magnus.
ULNAR,	CUBITALIS,
Highest interosseal perforant,	Arteria interossea perforans suprema,
Ulnar recurrent,	recurrens cubitalis,
Nutritious of the ulna,	nutritia ulnæ,
Common interosseal,	interossea communis,
Dorsal of the hand,	dorsalis manus,
Ulnar profunda,	cubitalis manus profunda,
Vola ulnar of the little finger,	Arteria volaris cubitalis digiti minimi,
First vola-digital,	digitalis volaris prima,
Second vola-digital,	secunda,
Third vola-digital,	tertia,
Large anastomotic,	Ramus anastomoticus magnus,
Nameless branches.	

RADIAL,	RADIALIS,
Radial recurrent,	Arteria recurrens radialis,
Superficial volar,	superficialis volæ,
Dorso-radial of the thumb,	dorsalis policis radialis,
Dorso-ulnar of the thumb,	ulnaris,
Dorso-carpal,	carpea,
Dorso-radial,	interossea indicis major, s. radialis,
Pollicar, or artery of the thumb,	princeps pollicis,
Superior volar perforants,	perforantes superiores,
Inferior volar perforants,	inferiores,

BRANCHES FROM THE DESCENDING AORTA.

THORACIC AORTA,	AORTA THORACICA,
Superior and posterior pericardiac,	Arteria pericardiaca posterior superior,
Common bronchial,	bronchialis communis,
Right bronchial,	dextra,
Left bronchial,	sinistra,
Inferior brochial,	bronchialis inferior,
Œsophageal,	œsophageæ,
Inferior intercostals,	intercostales inferiores,
VENTRAL AORTA,	AORTA VENTRALIS,
Phrenic—right and left,	phrenica, dex. et sinistra,
COELIAC,	COELICA,
Superior coronary,	coronaria superior,
Hepatic,	hepatica,
Splenic,	splenica,
SUPERIOR MESENTERIC,	MESENTERICA SUPERIOR,
Posterior pancreatics,	pancreaticæ posteriores
Left inferior duodenals,	duodenales infer. sinist.
Superior colic,	colica superior,
Ileo-colic,	ileo-colica,

INFERIOR MESENTERIC,	MESENTERICA INFERIOR,
Left colic,	colica sinistra,
Internal hæmorrhoidal,	hæmorrhoidalis internalis,
Capsular, or atrabiliary,	capsulares, s. atrabiliariæ,
Renal, or emulgent,	renalis, s. emulgens,
Spermatic—right and left,	spermatica—dextra et sinistra,
Adipose—right and left,	adiposa—dextra et sinist.
Ureterics,	uretericæ,
Lumbar—right and left,	lumbalis—dextra et sinist.

BRANCHES FROM THE TERMINATION OF THE AORTA.

COMMON ILIAC,	ILIACA COMMUNIS,
INTERNAL ILIAC,	ARTERIA ILIACA INTERNA,
Ileo-lumbar,	Ileo-lumbalis,
Sacro-laterals,	sacræ laterales,
Umbilical,	umbilicalis,
Inferior vesicals,	vesicales imæ,
Middle hæmorrhoidal,	hæmorrhoidea media,
Uterine,	uterina,
Obturator,	obturatoria,
Posterior iliac, or gluteal,	iliaca posterior, s. glutea,
Ischiadic,	ischiadica,
Common pudic, or pudic,	Arteria pudenda communis,
EXTERNAL ILIAC,	ILIACA EXTERNA,
Epigastric,	Arteria epigastrica
Circumflex iliac,	circumflexa ileum, &c.

COMMON FEMORAL,	FEMORALIS COMMUNIS,
Superior external pudic,	Arteria pudenda exter. superior,
Middle external pudic,	externa media,
Inferior external pudic,	externa inferior,
DEEP FEMORAL,	FEMORALIS PROFUNDA,
External circumflex,	Arteria circumflexa externa,
Internal circumflex,	interna,
First perforant,	perforans prima,
Second perforant,	secunda,
SUPERFICIAL FEMORAL,	FEMORALIS SUPERFICIALIS,
Large anastomotic,	Ramus anastomoticus magnus,
Superior perforant,	perforans superior,
Inferior perforant,	inferior,
POPLITEAL,	POPLITEA,
Superior externo-articular,	Arteria articularis super. externa,
Superior interno-articular,	super. interna,
Middle articular,	media,s.azygos,
Inferior externo-articular,	infer. externa,
Inferior interno-articular,	infer. interna,
ANTERIOR TIBIAL,	TIBIALIS ANTICA,
Tibial recurrent,	Arteria tibialis recurrens,
Internal malleolar,	malleolaris intena,
External malleolar,	externa,
Transverse tarsal, or tarsal,	Arteria tarsea,
Transverse metatarsal,	metatarsea,
Dorso-metatarsal,	dorsa externa halucis,
Deep anastomotic,	Ramus anastomoticus profundus.
The POSTERIOR TIBIAL,	TIBIALIS POSTICA,
Posterior interosseal,	Arteria interossea posterior,
Common fibular,	peronea communis,
External plantar,	Plantaris externa,
Internal plantar,	interna,

SECTION II.

ANGIOLOGY.

DIVISION III.

OF THE VENAL SYSTEM.

OF THE VEINS IN GENERAL.

THE veins in many particulars resemble the arteries. There are six great veins; of which two answer to the aorta, and the remaining four to the pulmonary artery. Some count a seventh trunk, by taking in the venæ hepaticæ. Their basis is in the ventricles of the heart, and their apices in the extremities of each branch through all parts of the body, excepting one instance in the liver; or we may reverse this order, and say the veins terminate in the heart. In a great number of parts they run parallel with the arteries, one by the side of the other; but yet they differ from the arteries in various respects.

The fabric of the veins is slender, every where smooth, difficultly separable into distinct coats or membranes, like the arteries; and the cellular texture surrounding this fabric is very easily distended. This fabric, both above and below the heart, is surrounded, except in one place, with muscular fibres. Every where, however, it is lax like the cellular texture of the arteries by which they are joined to the other parts of the body. Notwithstanding this slender fabric, the veins are every where sufficiently firm, and do not easily burst with inflated air; being, in most instances, stronger than the arteries themselves. But they burst much more easily in living than in dead animals, as appears from morbid instances in the arm, face, leg, thigh, &c. Nor do they support themselves like cylinders after being divided, but they collapse so as to make their capacity appear like a slit, and they have no pulsation.

The veins are much larger than their corresponding arteries, having the square of their diameter often double or triple, and

almost quadruple; as near as the emulgents and vessels of the kidneys. In general, however, the diameter of the veins is to that of the arteries as nine to four; yet the capacity of the capillary veins but little exceeds that of the arteries which accompany them. They differ likewise from the arteries in their division, having more numerous trunks and branches; for to one artery in the limbs, we usually meet with two veins: and there are many veins, as the external jugular, vena portarum, azygos, cephalic, basilic, and saphena, with which no arteries correspond. The larger veins are also branched in a more net-like disposition, by forming more frequent anastomoses one with another. Many of the veins run near the surface of the body, and through the limbs, neck, and head, they run a long way covered with little more than the bare skin, a circumstance very rarely observed in arteries; and, for the same reason, they often go out in their course to a considerable distance from the arteries. In the smaller branches of the vessels, where they make net-like dispositions in the membranes and the internal fabric of the viscera, the veins have generally a less serpentine or inflected course than the arteries.

In the larger veins, valves are found in great plenty. The innermost membrane of the vein being double, rises into the cavity of the vessel like a curtain, stretching itself farther along the vein every way, so as to form what may be called a kind of crescent; but the basis, which is the part that sustains the weight of the blood, is strongest, and grows out of the vein in the shape of a circular segment. These, joined with the side of the preceding vein, intercept a space, of which the outer side is the vein itself, and the inner the valve, which so stands out within the vein, that the parabolic space or hollow mouth of the valves always looks toward the heart. They are found in all the subcutaneous veins of the limbs, in these of the neck, face, tongue, and in the veins of the penis: at the origin of the larger branches there are two, three, four, and sometimes five of them together, while in their smaller branches they are only single. There are none of these valves in the deep-running veins of the viscera; and, therefore, none in those of the brain,

lungs, heart, or liver, or through the whole system of the vena portarum; nor in the kidnies or womb (except one or two valves in the spermatic vein); nor, lastly, are there any in those smaller blood-veins which are of a less diameter than the twelfth part of an inch. Sometimes, though rarely, they are found in the branches of the vena azygos, and at the mouths of the hepatic and renal veins: there Haller has several times observed a sort of wrinkles in the place of valves. In the smaller venous branches there are a set of long, sharp-pointed or parabolical valves, of a more extended figure as the vein is smaller: and these make a greater resistance than the larger valves.

The veins have their origin, as we said before, from the terminations of the arteries.

That there are veins of a smaller class, but resembling those which convey blood, appears from the same experiments which demonstrate the pellucid arteries: thus in the iris of the eye there are small veins, and not a few in the adnata tunica of that organ; nor is it to be doubted, that, in a healthy body, small pellucid veins may be found in the vitreous body of the eye itself. Such have been sometimes seen by Wrisberg and others, after a fine injection or inflammation in the capsules of the lens and vitreous humour.

OF THE PARTICULAR VEINS.

The blood distributed to all parts of the body by two kinds of arteries, the aorta and arteria pulmonaris, returns by three kinds of veins, called by anatomists *vena cava*, *vena portæ*, and *vena pulmonaris*.

The vena cava carries back to the right auricle of the heart the blood conveyed by the aorta to all the parts of the body, except what goes by the arteriæ coronariæ cordis. It receives all this blood from the arterial ramifications in part directly, and in part indirectly.

The venæ portæ receives the blood carried to the floating viscera of the abdomen by the arteria cæliaca and the two mesentericæ; and conveys it to the vena hepatica, and from thence to the vena cava.

The venæ pulmonares convey to the pulmonary sinus, or left auricle of the heart, the blood carried to the lungs by the arteria pulmonaris.

General division of the vena cava. The vena cava goes out from the right auricle of the heart by two large separate trunks, in a direction almost perpendicularly opposite to each other, one running upward, called *vena cava superior*; the other downward, called *vena cava inferior.* It may, however, be said, that these two veins have a sort of continuity.

The right auricle may also be looked upon as a muscular trunk common to these two large veins, and may be called the *sinus* of the vena cava; but in this respect, the name of *sinus pulmonaris* agrees still better to it.

The vena cava superior is distributed chiefly to the thorax, head, and upper extremities, and but very little to the parts below the diaphragm; while the vena cava inferior is distributed chiefly to the abdomen and lower extremities, and but very little to the parts above the diaphragm.

VEINS OF THE HEAD AND NECK.

Vena jugularis externa anterior. Numerous lesser veins empyting themselves into the vena angularis, are the source of this vein.

The vena angularis runs down upon the face in a winding manner from the inner angle of the eye, receiving branches on each side from the muscles and integuments. It passes next over the lower jaw near the angle of that bone, and becomes the anterior external jugular vein.

In its course, it receives a large branch, which communicates with some branches of the jugularis-interna, and also the *venæ raninæ*, &c.

It is to be observed, that, under the angle of the lower jaw, there is a great variety of communications between the external and internal jugular veins, and also a great variety in the distribution of these veins.

Opposite to the cartilago thyroides, it receives a transverse

branch, which runs on the anterior or lower part of the musculi sterno-mastoidæi, and communicates with the jugularis of the other side.

The trunk of the vein thus formed sometimes runs down to open into the subclavian vein ; but most commonly it opens into the communication of the temporal vein, a little below the jaw.

Vena jugularis externa posterior, sive superior. This vein is at first formed by a branch called *vena temporalis,* which receives the blood from the temples and lateral parts of the head. Sometimes the temporal vein has two insertions, whereof one is into the jugularis interna.

Having received numerous small branches, it passes through the parotid gland, and the external jugular being now formed of the facial, and of the temporal vein, runs down between the musculus platysma myoides and sterno-mastoideus, being covered by the former, and crossing over the latter. In this course it receives posteriorly the vena occipitalis, which comes from the different parts of the occiput.

And a branch from the scapula, called *muscularis* or *superhumeralis.* It then ends in the subclavian on the same side, sometimes in the axillaris, and sometimes in the union of these two veins. The right and left do not always end in the same manner ; for sometimes the right goes into the subclavian, and the left into the internal jugular, on the same side.

At the lower part of the neck it receives the vena cervicalis, which comes from the vertebral muscles of the neck, and a principal branch from the muscles which cover the scapula and joint of the humerus, commonly called *vena muscularis,* or *super-humeralis.*

Vena jugularis interna. The internal jugular vein is the largest of all those that come from the head ; though not so large as it seems to be when injected.

It is a continuation of the lateral sinus, which, after getting through the foramen lacerum of the basis crani, bends a little, and forms a sort of varix, which fills a thimble-like cavity in the temporal bone. From this it runs along the sides of the vertebræ of the neck, by the edges of the longus colli, and passes behind the sterno-mastoidæus and omo-hyoidæus, which it

crosses, and ends in the subclavian vein, after receiving the *guttural* vein from about the larynx, and others of less note.

Vena vertebralis. The vertebral vein accompanies the artery of the same name, sometimes in one trunk, sometimes in several stems, through all the holes of the transverse apophyses of the vertebræ colli, all the way from the great foramen occipitale, after communicating with the occipital veins, the small occipital sinuses of the dura mater, and various lesser veins. It ends in the upper and back part of the subclavian.

VEINS OF THE SUPERIOR EXTREMITIES.

The veins of the extremities run in two sets, one following the arteries, the other running immediately under the skin; we shall trace them from their origins to their terminations in the subclavian vein.

In general, the external or superficial veins of the fore-arm are larger than the internal; but they are accompanied only by small arteries, whereas the deep veins accompany large arteries.

Vena basilica. This vein takes its origin by several branches which come from the convex side of the carpus; and after receiving these branches, runs along the ulna, between the integuments and muscles, a little toward the outside, by the name of *cubitalis externa*, communicating with the veins called *profunda, satellites*, and *cephalica*. Having reached the inner condyle, it receives two branches; the larger is the *mediana basilica*, which opens into it obliquely.

Afterward the basilica runs up along the inside of the os humeri, between the muscles and integuments, forming many communications with the vena profunda, satellites, and cephalica, and receiving many inferior branches.

Having reached the side of the head of the os humeri, terminates in the trunk of the vena axillaris, which may be considered as a continuation of it.

Vena cephalica. The vena cephalica receives, at the extremity of the radius, branches which correspond with those of the radial artery. A branch also comes into it, which runs more or less superficially between the thumb and metacarpus, by the name of *cephalica pollicis*.

From the under part of the fore-arm the trunk of the vein runs in the course of the radius, receiving branches from both sides, which communicate with other branches of the same vein, and with some of the basilica. That part of the vein which lies on the fore-arm may be looked upon as a radialis externa.

Having reached a little below the fold of the arm, it receives a large branch, called *mediana cephalica.* This com s up obliquely from the middle of the fold of the arm, over the tendon of the biceps. These two medianæ are sent off in an angle, the apex of which is turned downward. The mediana cephalica sometimes receives a long branch called *radialis interna,* which lies almost parallel to the radialis externa.

The two median veins are sent off from a trunk which may be called *mediana major,* or *longa,* to distinguish it from the other two. This trunk runs up from the fore-arm between the cephalic and basilic veins, communicating with both in its passage by many branches. At the part where it splits into the two branches already named, a branch opens into it called *vena cubiti profunda.*

Having received some trivial branches, the cephalica then runs between the deltoid and large pectoral muscles, communicating in its passage with a branch called *small cephalic,* and terminates in the vena axillaris.

Vena axillaris. This vein formed by all the veins from the superior extremity, receives, above the axilla, the venæ thoracicæ; one of which is superior, called also *mammaria externa;* and the other inferior. Having received these and other lesser branches, it passes between the first rib and the clavicle, where it gets the name of *subclavian;* then before the anterior portion of the musculus scalenus; and at last meets with its fellow on the opposite side, to form the vena cava superior.

VEINS OF THE THORAX.

Venæ pectorales internæ. The pectorales internæ, are small veins disposed in pairs toward the right and left side, behind the sternum and parts near it, including the diaphragmatics supe-

riores, or pericardia diaphragmaticæ, mediastinæ, mammariæ internæ, thymicæ, pericardiæ, and gutturales or tracheales.

All these small veins are divided into right and left; and these are both distributed much in the same manner; but they differ in their terminations, because of the inequality in the bifurcation of the cava superior.

Vena azygos, and venæ intercostales. The vena azygos, or sine pari, is very considerable, and arises from the lower side of the thorax internally.

For at the back part of the diaphragm, it communicates, by a very sensible anastomosis, sometimes with the vena renalis, sometimes with a neighbouring lumbar vein, sometimes immediately with the trunk of the cava inferior, and sometimes otherwise.

From the left side of the thorax it runs across the spine, and afterwards ascends on the right side of the vertebræ dorsi and aòrta, and before the intercostal arteries.

At the top of the thorax it is bent forward over the origin of the right lung, forming an arch which surrounds the great pulmonary vessels on that side, as the arch of the aorta does those of the left side, with this difference only, that the curvature of the azygos is almost directly forward, whereas that of the aorta is oblique. It opens posteriorly, a little above the pericardium, into the top of the superior cava.

Vena subclaviana. The subclavian vein is formed chiefly by veins from the head, neck, and arms. It passes over the insertion of the anterior scalenus muscle, between the clavicle and first rib.

The right subclavian, which is the shortest of the two, commonly receives four capital branches, viz. the jugularis externa, jugularis interna, vertebralis, and axillaris, of which last the subclavian may be looked upon as a continuation.

The left suclavian being longer than the right, because the vena cava, into which both open, lies in the right side of the thorax, receives first the four capital branches, corresponding with those already mentioned, as going into the right subclavian. Next to these, it receives a vein, somewhat similar to the vena azygos, called *intercostalis superior,* which is formed

of branches coming sometimes from five or six of the superior intercostal muscles; and other lesser veins. Besides these, it receives the termination of the thoracic duct, already described.

After admitting the branches mentioned above, the two venæ subclavianæ unite at the upper end of the thorax, near the cartilage of the first rib, and form the vena cava superior, which receives the vena azygos, and runs down about an inch, somewhat inclining to the right side; at this part it enters the pericardium, and descends nearly in a direct course for about two fingers breadth in an ordinary sized person, being situated on the right side of the aorta, but a little more anteriorly. It opens at last in the upper part of the right auricle.

VEINS OF THE CHYLOPOIETIC AND ASSISTANT CHYLOPOIETIC VISCERA.

Vena mesaraica minor, or hæmorrhoidalis interna. Returning the blood of cæliac and mesenteric arteries. Its commencement is near the anus, and it constitutes one of the three principal branches of the vena portæ, opening commonly into the termination of the vena splenica, and sometimes into the beginning of the great trunk of the vena portæ.

Vena splenica. The splenic vein is one of the three great branches of the vena portæ, and may be said in some measure to be a subordinate trunk of that vein. It runs transversely from the left to the right side, first along the lower side of the pancreas, near the posterior edge, and then under the duodenum.

In this course it receives several veins, viz. the vena coronaria ventriculi, pancreaticæ, gastrica, or gastro-epiploica sinistra, and epiploica dextra. It likewise often receives the hæmorrhoidalis interna, already described.

Vena mesaraica major. The blood of the small intestines, cæcum and right part of the colon, is returned from most of the branches of the superior mesenteric artery by this vein which runs up to the inferior vena portæ, and appears in some measure to form it. As it runs along it forms an arch almost like that of the artery.

Into the concave side of the mesaraic vein, passes the *vena cœcalis*, which runs from the beginning of the colon, crossing one of the branches of the superior mesenteric artery.

Afterward the trunk of the mesaraica passes over the superior mesenteric artery, to which it adheres very closely; but previous to this it receives several branches into the convex side of its arch. It receives sometimes opposite to the gastrica, a particular branch from the omentum, called *epiploica dextra*. But almost immediately after it descends over the mesenteric artery, it gets the addition of two large branches very near each other, which pass behind and under the artery, coming from the jejunum and part of the ilium.

The trunk of the great mesaraic vein running farther, receives a vein which may be called *gastro colica;* this is formed of two branches, one superior, the other inferior.

The last particular branch running into this trunk is the *vena colica*. It opens into the anterior part of the trunk, before it joins the artery, and comes directly from the middle of the colon; and here it is formed of branches from the right and left, which communicate with others by arches.

The vein, after having been distributed like the artery, runs through those parts of the mesentery and mesocolon which belong to the small intestines, the cæcum, and right portion of the colon; it passes next over the trunk of the arteries, receiving in its way the splenic vein, and terminates at last in the vena portæ.

Venæ portæ. The inferior vena portæ, after being formed of the splenic and mesenteric veins, receives into its trunk several small rami, which are commonly the venæ cysticæ, hepatica, minor, pylorica, duodenalis, and sometimes the gastrica dextra, and coronaria ventriculi. The trunk composed of the two mesenterics and splenic veins passing on the vena gastrica, or gastro-epiploica dextra, and the coronaria ventriculi, but these go sometimes into some of the larger branches.

The duodenal vein, commonly called *vena intestinalis*, goes into the trunk near the cysticæ, and sometimes into the small common trunk of these veins. It comes chiefly from the intestinum duodenum, and receives likewise some rami from the pan-

creas. There is another vein called also *duodenalis*, which terminates in the gastrica of the same side.

The vena pylorica terminates in the great trunk, almost opposite to the end of the cysticæ, and sometimes goes into the right gastrica. It passes over the pylorus from the short arch of the stomach, where it is joined by anastomosis with the coronaria ventriculi.

The cystic veins run along the vesicula fellis from its bottom to its neck. They go into the right side of the great trunk near its end, sometimes separately, sometimes by a small and very short common trunk.

The small hepatic vein is commonly a branch of one of the cysticæ, or of their common trunk.

The large trunk of the vena portæ inferior or ventralis, is situated under the lower or concave side of the liver, and joined by an anastomosis to the sinus of the vena portæ hepatica, between the middle and right extremity of that sinus, and consequently at a good distance from the left extremity. Thence it runs up a little obliquely from left to right, behind or under the trunk of the arteria hepatica, its length being about five fingers breadth.

At the head of the pancreas, this trunk may be said to begin by the three branches already described.

The last portion of this vein may be termed *vena portæ hepatica*, superior or minor, the trunk of which is commonly known by the name of *sinus venæ portarum*. The other portion may be called *vena portæ ventralis*, inferior or major.

The vena portæ may be considered as made up of two large veins, joined almost endwise by their trunks, from each of which the branches and ramifications go out in contrary or opposite directions. One of these parts comes from the stomach and intestines, with the spleen and pancreas, and has been already described; the other goes to the liver.

VEINS OF THE INFERIOR EXTREMITIES.

The blood is returned from the inferior extremities by a superficial and deep set of veins, somewhat in a similar manner to

what we have described in the superior extremities. Of the superficial veins we find one called *saphena major*, and another called *saphena minor*. The deep veins have the same names with the arteries which they accompany.

Vena saphena major. This begins at the great toe, then runs between the first two metatarsal bones irregularly under the skin towards the inner ancle.

At the great toe it receives a kind of transverse arch over the metatarsus, which communicates by several branches with an arch which lies on the joint of the tarsus, and gets others from the toes. This arch receives likewise another branch, which runs down behind the outer ancle, having communicated with the vena tibialis externa.

Under the inner ancle, it receives a branch inward and forward, which runs under, and in some measure accompanies, the anterior tibial artery. Interiorly, it receives another branch at the same place, which passes up from the sole of the foot, communicating with the external tibial vein by irregular arches. This in its passage receives branches from the toes. In its course upward it receives also other branches.

From the leg the saphena passes along the inside of the knee and afterwards along the thigh, as far as the middle of the sartorius muscle ; and there receives several branches. It passes afterward to the forepart of the thigh, having been covered in all its passage by skin and fat only. At the groin it receives branches from the inguinal glands and neighbouring parts, and opens at last into the top of the femoral vein.

Vena saphena minor. The vena saphena minor returns the blood from the outer side of the foot by many small branches, which communicate freely with each other. From this part it runs up at the outside of the tendo Achillis ; and, next, between the gastrocnemius exturnus and skin.

Immediately above and below the ham, this vein receives branches, which likewise communicate with each other, and with the saphena major.

At the ham, a branch forms a communication between it and the crural vein, receiving small anastomosing branches in its

ascent. It terminates at last a little above the ham in the trunk of the vena poplitea.

The *Vena tibialis anterior*, *tibialis posterior*, and *peronea* are each of them double veins, accompanying their respective arteries.

Vena poplitea. The vena poplitea, formed of the three last described, runs up immediately behind the muscle of the same name, and receives several ramifications in its ascent.

A little above the ham, it gets the name of *crural vein*, which runs up between the biceps and other flexors of the leg, closely accompanied by the crural artery; between which and the inner condyle of the os femoris it is situated. A little above the ham it receives the vena saphena minor from the back part of the leg. The trunk of the vein runs now up on the thigh behind the crural artery, till it gets opposite to the trochanter minor. About an inch below Poupart's ligament, the crural vein receives the saphena major, and the *pudicæ externæ*. After this the trunk of the vein goes into the abdomen under Poupert's ligament, on the inside of the corresponding artery.

VEINS OF THE PELVIS.

Vena iliaca externa After the crural vein gets from under the ligamentum Fallopii, it is called *vena iliaca externa*, then receives the vena epigastrica, and joins a large vein from the cavity of the pelvis called *vena iliaca interna*, or *hypogastrica*.

Vena iliaca interna. The hypogastric or internal iliac vein, runs behind the artery of the same name, making the same kind of arch, into which the following branches open.

Of the branches which form the hypogastric vein, we find first a large branch running from the lower part of the os sacrum, and two or more which come upward through the notch of the os ilium from the buttocks, anus, neighbouring portion of the musculus pectineus, and from the external parts of generation, nearly in the same manner with the artery which accompanies them.

The veins that come from the anus, are termed *hæmorrhoidales externæ;* and those that come from the parts of genera-

tion, *pudicæ internæ*. The external hemorrhoidales communicate with the internal veins of the same name, which go to the small vena mesariaca, one of the branches of the vena portæ.

Within the pelvis it receives a large branch called *vena obturatrix* through the obturator foramen which interiorly, receives branches from the ureters, bladder, and internal parts of generation in both sexes. After receiving these different branches, the iliaca interna joins the external iliac vein.

Vena iliaca communis. The hypogastric vein, running up in the pelvis, joins the external iliac to form the common iliac vein, in the same manner that the iliac arteries are connected with the aorta; but the union is about a finger's breadth lower than the bifurcation of the aorta.

The external vein in adults seems to be in a line with the common iliac, and the hypogastrica only a branch; but in the fœtus there is a considerable variation.

These veins follow nearly the course and distribution of the iliac arteries, except that the hypogastric vein does not receive the vena umbilicalis. The external iliac veins lie more or less on the inside of the arteries, in the manner already said; but the hypogastric veins, in the bottom of the pelvis, lie almost behind the arteries on the same side.

VEINS ON THE BACK PART OF THE ABDOMEN AND LOINS.

The two common iliac veins unite to form the vena cava. Into this union, and often into the end of the left iliaca, the vena sacra goes in, having accompanied the artery of the same name in its distribution to the os sacrum, to the nerves which lie there, and to the membranes which cover both sides of that bone.

The extremity of the trunk of the vena cava, lies in some subjects behind the origin of the right iliac artery; in others, it is the left iliac vein which passes there, and consequently crosses the right iliac artery. The cava passes up through the abdomen on the forepart of the lumbar vertebræ, and on the right side of the aorta.

It receives posteriorly the venæ lumbares; which commonly

end in pairs, in the same manner as the corresponding arteries go out from the aorta.

Having got as high as the arteriæ renales, the vena cava receives the veins of the same name, termed formerly *venæ emulgentes*, and which are the largest of all the veins that go to the cava inferior, from the beginning to the part where it runs behind the liver.

The right renal vein is the shortest, and runs up a little obliquely because of the situation of the kidney. The left vein, which is the longest, crosses on the fore side of the trunk of the aorta, immediately above the superior mesenteric artery, and both veins accompany the renal arteries.

In its course, the vena cava receives also the venæ capsulares, the left renal vein, the phrenicæ, the hepaticæ, and, in the fœtus, the ductus venosus.

Having received these branches, it perforates the tendinous portion of the diaphragm and the pericardium ; and running a quarter of an inch or so within the pericardium, opens into the under part of the right auricle.

END OF PART AND VOL. II.

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